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LITARY MEDICAL MANUALS

GENERAL EDITOR:
RGEON-GEN. SIR ALFRED KEOGH
G.C.B., M.D., F.R.C.P.

TYPHOID FEVERS AND PARATYPHOID FEVERS

H. VINCENT & L. MURATET
EDITED BY
J. D. ROLLESTON

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MILITARY MEDICAL MANUALS

General Editor :

SIR ALFRED KEOGH, G.C.B., M.D., F.R.C.S.

TYPHOID FEVER AND PARATYPHOID FEVERS

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TYPHOID FEVER AND PARATYPHOID FEVERS

(SYMPTOMATOLOGY, ETIOLOGY AND PROPHYLAXIS)

BY

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TRANSLATED FROM THE SECOND AND REVISED EDITION AND EDITED BY

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GENERAL INTRODUCTION

The infinite variety of injuries which any war presents to the surgeon gives to military surgery a special interest and importance. The special interest and importance, in a surgical sense, of the great European War lies not so much in the fact that examples of every form of gross lesion of organs and limbs have been seen, for if we read the older writers we find little in the moderns that is new in this respect, but is to be found in the enormous mass of clinical material which has been presented to us and in the production of evidence sufficient to eliminate sources of error in determining important conclusions. For the first time also in any campaign the labours of the surgeon and the physician have had the aid of the bacteriologist, the pathologist, the physiologist and indeed of every form of scientific assistance in the solution of their respective problems. The clinician entered upon the great war armed with all the resources which the advances of fifty years had made available. If the surgical problems of modern war can be said not to differ sensibly from the campaigns of the past, the form in which they have been presented is certainly as different as are the methods of their solution. The achievements in the field of discovery of the chemist, the physicist and the biologist have given the military surgeon an advantage in diagnosis and treatment which was denied to his predecessors, and we are able to measure the effects of these advantages when we come to appraise the results which have been attained.

But although we may admit the general truth of these statements it would be wrong to assume that modern scientific knowledge was, on the outbreak of the war, immediately useful to those to whom the

wounded were to be confided. Fixed principles existed in all the sciences auxiliary to the work of the surgeon, but our scientific resources were not immediately available at the outset of the great campaign; scientific work bearing on wound problems had not been arranged in a manner adapted to the requirements, indeed the requirements were not fully foreseen; the workers in the various fields were isolated, or isolated themselves pursuing new researches rather than concentrating their powerful forces upon the one great quest.

However brilliant the triumphs of surgery may be, and that they have been of surpassing splendour no one will be found to deny, experiences of the war have already produced a mass of facts sufficient to suggest the complete remodelling of our methods of education and research.

The series of manuals, which it is my pleasant duty to introduce to English readers, consists of translations of the principal volumes of the "Horizon" Collection which has been appropriately named after the uniform of the French soldier.

The authors, who are all well-known specialists in the subjects which they represent, have given a concise but eminently readable account of the recent acquisitions to the medicine and surgery of war which had hitherto been disseminated in periodical literature.

No higher praise can be given to the Editors than to say that the clearness of exposition characteristic of the French original has not been lost in the rendering into English.

MEDICAL SERIES

The medical volumes which have been translated for this series may be divided into two main groups, the first dealing with certain epidemic diseases including syphilis, which are most liable to attack soldiers, and the second with various aspects of the neurology of war. The last word on *Typhoid Fever*, hitherto "the greatest scourge of armies in time of war," as it has been truly called, will be found in the mono-

graph by MM. Vincent and Muratet which contains a full account of recent progress in bacteriology and epidemiology as well as the clinical features of typhoid and paratyphoid fevers. The writers combat a belief in the comparatively harmless nature of paratyphoid and state that in the present war hæmorrhage and perforation have been as frequent in paratyphoid as in typhoid fever. In their chapter on diagnosis they show that the serum test is of no value in the case of those who have undergone anti-typhoid or anti-paratyphoid vaccination and that precise information can be gained by blood cultures only. The relative advantages of a restricted and liberal diet are discussed in the chapter on treatment, which also contains a description of serum-therapy and vaccine-therapy and the general management of the patient.

Considerable space is devoted to the important question of the carrier of infection. A special chapter is devoted to the prophylaxis of typhoid fever in the army. The work concludes with a chapter on preventive inoculation in which its value is conclusively proved by the statistics of all countries in which it has been employed.

MM. Vincent and Muratet have also contributed to the series a work on *Dysentery, Cholera and Typhus* which will be of special interest to those whose duties take them to the Eastern Mediterranean or Mesopotamia. The carrier problem in relation to dysentery and cholera is fully discussed, and special stress is laid on the epidemiological importance of mild or abortive cases of these two diseases.

In their monograph on *The Abnormal Forms of Tetanus*, MM. Courtois-Suffit and Giroux treat of those varieties of the disease in which the spasm is confined to a limited group of muscles, *e. g.* those of the head, or one or more limbs, or of the abdomino-thoracic muscles. The constitutional symptoms are less severe than in the generalised form of the disease, and the prognosis is more favourable.

The volume by Dr. G. Thibierge on *Syphilis in the*

Army is intended as a *vade-mecum* for medical officers in the army.

Turning now to the works of neurological interest, we have two volumes dealing with lesions of the peripheral nerves by Mme. Atanassio Benisty, who has been for several years assistant to Professor Pierre Marie at La Salpêtrière. The first volume contains an account of the anatomy and physiology of the peripheral nerves, together with the symptomatology of their lesions. The second volume is devoted to the prognosis and treatment of nerve lesions.

The monograph of MM. Babinski and Froment on *Hysteria or Pithiatism and Nervous Disorders of a Reflex Character* next claims attention. In the first part the old conception of hysteria, especially as it was built up by Charcot, is set forth, and is followed by a description of the modern conception of hysteria due to Babinski, who has suggested the substitution of the term "Pithiatism," *i. e.* a state curable by persuasion, for the old name hysteria. The second part deals with nervous disorders of a reflex character, consisting of contractures or paralysis following traumatism, which are frequently found in the neurology of war, and a variety of minor symptoms, such as muscular atrophy, exaggeration of the tendon reflexes, vasomotor, thermal and secretory changes, etc. An important section discusses the future of such men, especially as regards their disposal by medical boards.

An instructive companion volume to the above is to be found in the monograph of MM. Roussy and Lhermitte, which embodies a description of the psychoneuroses met with in war, starting with elementary motor disorders and concluding with the most complex represented by pure psychoses.

SURGICAL SERIES

When the present war began, surgeons, under the influence of the immortal work of Lister, had for more than a quarter of a century concerned themselves

almost exclusively with elaborations of technique designed to shorten the time occupied in or to improve the results obtained by the many complex operations that the genius of Lister had rendered possible. The good behaviour of the wound was taken for granted whenever it was made, as it nearly always was, through unbroken skin, and hence the study of the treatment of wounds had become largely restricted to the study of the aseptic variety. Septic wounds were rarely seen, and antiseptic surgery had been almost forgotten. Very few of those who were called upon to treat the wounded in the early autumn of 1914 were familiar with the treatment of grossly septic compound fractures and wounded joints, and none had any wide experience. To these men the conditions of the wounds came as a sinister and disheartening revelation. They were suddenly confronted with a state of affairs, as far as the physical conditions in the wounds were concerned, for which it was necessary to go back a hundred years or more to find a parallel.

Hence the early period of the war was one of earnest search after the correct principles that should be applied to the removal of the unusual difficulties with which surgeons and physicians were faced. It was necessary to discover where and why the treatment that sufficed for affections among the civil population failed when it was applied to military casualties, and then to originate adequate measures for the relief of the latter. For many reasons this was a slow and laborious process, in spite of the multitude of workers and the wealth of scientific resources at their disposal. The ruthlessness of war must necessarily hamper the work of the medical scientist in almost every direction except in that of providing him with an abundance of material upon which to work. It limits the opportunity for deliberate critical observation and comparison that is so essential to the formation of an accurate estimation of values; it often compels work to be done under such high pressure and such unfavourable conditions that it becomes of little value for educative purposes.

In all the armies, and on all the fronts, the pressure caused by the unprecedented number of casualties has necessitated rapid evacuation from the front along lines of communication, often of enormous length, and this means the transfer of cases through many hands, with its consequent division of responsibility, loss of continuity of treatment, and absence of prolonged observation by any one individual.

In addition to all this, it must be remembered that in this war the early conditions at the front were so uncertain that it was impossible to establish there the completely equipped scientific institutions for the treatment of the wounded that are now available under more assured circumstances, and that progress was thereby much hampered until definitive treatment could be undertaken at the early stage that is now possible.

But order has been steadily evolved out of chaos and many things are now being done at the front that would have been deemed impossible not many months ago. As general principles of treatment are established it is found practicable to give effect to them to their full logical extent, and though there are still many obscure points to be elucidated and many methods in use that still call for improvements, it is now safe to say that the position of the art of military medicine and surgery stands upon a sound foundation, and that its future may be regarded with confidence and sanguine expectation.

The views of great authorities who derive their knowledge from extensive first-hand practical experience gained in the field, cannot fail to serve as a most valuable asset to the less experienced, and must do much to enable them to derive the utmost value from the experience which will, in time, be theirs. The series covers the whole field of war surgery and medicine, and its predominating note is the exhaustive, practical and up-to-date manner in which it is handled. It is marked throughout not only by a wealth of detail, but by clearness of view and logical

sequence of thought. Its study will convince the reader that, great as have been the advances in all departments in the services during this war, the progress made in the medical branch may fairly challenge comparison with that in any other, and that not the least among the services rendered by our great Ally, France, to the common cause is this brilliant contribution to our professional knowledge.

A glance at the list of surgical works in the series will show how completely the ground has been covered. Appropriately enough, the series opens with the volume on *The Treatment of Infected Wounds*, by A. Carrel and G. Dehelly. This is a direct product of the war which, in the opinion of many, bids fair to become epoch-making in the treatment of septic wounds. It is peculiar to the war and derived directly from it, and the work upon which it is based is as fine an example of correlated work on the part of the chemist, the bacteriologist and the clinician as could well be wished for. This volume will show many for the first time what a precise and scientific method the "Carrel treatment" really is.

The two volumes by Prof. Leriche on *Fractures* contain the practical application of the views of the great Lyons school of surgeons with regard to the treatment of injuries of bones and joints. Supported as they are by an appeal to an abundant clinical experience, they cannot fail to interest English surgeons, and to prove of the greatest value. It is only necessary to say the *Wounds of the Abdomen* are dealt with by Dr. Abadie, *Wounds of the Vessels* by Prof. Sencert, *Wounds of the Skull and Brain* by MM. Chatelin and De Martel, and *Localisation and Extraction of Projectiles* by Prof. Ombrédanne and R. Ledoux-Lebard, to prove that the subjects have been allotted to very able and experienced exponents.

ALFRED KEOGH.

PREFACE TO THE FIRST EDITION

Although typhoid fever is a widespread disease and is therefore a familiar subject to medical men, a clinical and epidemiological study, containing the principal modern acquisitions to our knowledge, will perhaps serve a useful purpose.

The abnormal or ill-developed forms of this disease frequently escape attention and diagnosis; it is therefore of some interest to describe their characters. Furthermore, the relatively recent discovery of paratyphoid fevers, the symptoms of which sometimes so closely reproduce those of typhoid fever that they cannot be distinguished without laboratory assistance, has not only completed but also complicated the clinical examination of enteric fever.

A description of these diseases was therefore needed. A knowledge of the prophylactic measures required for typhoid fever was equally important for the practitioner.

The aim of the present work has been to give a concise account of the progress made in the clinical, therapeutical and hygienic study of these affections, and above all to serve as a practical guide for the medical man.

It is for this reason that this work has been intentionally restricted to a description of the symptomatology, diagnosis, prophylaxis and treatment of typhoid and paratyphoid fevers.

The same purpose has guided us in our epidemiological study, which will perhaps be a new chapter to some medical men. This part of the subject has been dealt with in some detail, and we have discussed the

prophylaxis required in the army as well as in an urban and rural population.

We have no hesitation in saying that the composition of the work was influenced by the existence of the war during which it was written. We thought it our duty to try to be of service in the cantonments and the trenches as well as by the patient's bedside in hospital : in a word, in all those circumstances in which the medical man has to be guided by clinical examination alone, as well as in those in which he can rely on the help of a bacteriological expert.

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TYPHOID FEVER AND PARATYPHOID FEVERS

FIRST PART

CLINICAL STUDY

Few diseases have benefited so much from laboratory research as typhoid fever. The discovery of the specific bacillus and of its presence in the blood before the appearance of the earliest symptoms, has modified our ideas of the etiology and pathogeny of this affection. The narrow limits within which it had been enclosed have been extended. We should no longer regard it as a purely intestinal affection as did Louis, Chomel, Trousseau, Bretonneau, Murchison, Grisolle, Jaccoud, etc. It represents the secondary localisation of a general affection produced by a specific bacillus. It is only a variety—the most frequent one, it is true—of typhoid septicæmia, "in the course of which disorders of the digestive system, important as they are, are far from representing the principal symptom of the disease" (H. Roger).

It is just this septicæmic character of typhoid fever which can explain the abundance of its symptoms. On a fairly uniform substratum of general and nervous clinical signs a great variety of morbid phenomena develops, which in turn are due to some remarkable localisation of the bacillus, *e. g.* meningitis, or to the predominance of one particular symptom or another, or to the insidious or unexpected development of a secondary infection, the clinical expression of which is

superimposed upon and confounded with the signs peculiar to typhoid fever.

We may add that it is above all others a disease full of surprises, and one in which sudden collapse of organic resistance occurs when it is least to be expected.

The result is that there is some difficulty in including in a single description a complete account of all the features of typhoid fever.

In our endeavour to succeed in giving as clear and complete a description as possible, the symptoms of typhoid fever have been discussed in this work according to the following plan.

The first chapter contains a comprehensive survey of the clinical characters of the most frequent form of typhoid fever.

The principal clinical types are then dealt with individually in a special study.

Finally, with the object of completing the necessarily succinct portions of the previous description, each of the principal symptoms and their varieties are discussed according to their anatomical localisation.

This last clinical chapter is, therefore, the necessary complement of the previous chapters.

CHAPTER I

CLINICAL CHARACTERS OF TYPHOID FEVER : ORDINARY FORMS

THE clinical forms of typhoid septicæmia with an intestinal localisation are multiple, but are only variants of one particular form, viz. typical typhoid fever of moderate intensity. From the clinical point of view we may adopt the division into four periods, *incubation, invasion or onset, height of the disease* and *defervescence.* This division is based on the course of the temperature, since it is the temperature which is the chief guide to treatment throughout the disease, and regulates the hygiene of convalescence. The temperature enables us to follow the course of the disease and frequently to foretell complications or improvement.

Incubation.—As a rule it is impossible to determine the onset of the infection and the time which elapses between this onset and the first symptoms. In the great majority of cases, however, the duration of the incubation of typhoid fever is fourteen, sixteen or twenty days.

Under certain circumstances the incubation period is much longer, and may last from twenty to forty days (Jaccoud, Apert).

In a case of laboratory infection, typhoid fever developed in forty days (Vincent).

Epidemiological observations also furnish numerous instances of long incubation periods. One may see cases of typhoid fever breaking out at intervals ranging from two to four or five weeks, without any intercurrent cause for infection having intervened.

This latent period of incubation is, as a rule, uneventful. No sign reveals the infection until the day when it is manifested by malaise, headache, digestive disturbance, and a rise of temperature with or without shivering. This combination of symptoms, however ill-developed they may be, should be looked on with suspicion, especially during an epidemic. In the course of the latent period of the disease a slight rise of temperature may be noted, the thermometer may register 99·0°, 99·4° or 99·8° F., either in the morning, which is rare, or at night, which is more frequent. In practice and in cases of possible infection these slight rises of temperature should be looked for methodically and systematically. They indicate the invasion of the organism by the typhoid bacillus, and *at this moment* it is possible to find the pathogenic micro-organism in cultures of the blood.

Period of Invasion, or Onset.—In most cases the invasion takes place gradually, and the onset can only be determined retrospectively by questioning the patient.

The information so obtained is sometimes so indefinite that the doctor still feels in doubt, and has to reckon the onset of the disease from the day when the patient took to bed.

An individual who usually enjoys good health complains of having been out of sorts for several days. He feels tired and unsteady in his legs, he suffers from giddiness and tinnitus. His head feels heavy; all mental or physical exertion has become difficult, if not actually painful and distasteful. He is continually wanting to sleep, although at night his sleep is disturbed and he is constantly waking up. He has retained his clearness of mind and his memory, but when he speaks or answers questions put to him he does so with a certain effort. He complains of a slight pain in the lumbar region and his limbs. The appetite is lost, and there is a bitter taste in the mouth. The sight or smell of food sometimes causes nausea. The patient is constipated at first. The constipation is followed

by an ochre-coloured diarrhœa (four to five stools in the twenty-four hours), without colic. There is slight epistaxis. The urine is scanty. The skin is hot, the temperature is about 100·4° or 102·2°, the pulse quick, 110 to the minute. The features are drawn, the complexion slightly yellow, the cheeks red and the lips dry. The tongue is covered with a whitish coating and is red at the edges. The abdomen is slightly distended. On palpation one generally finds some tenderness and gurgling in the right iliac fossa. Pressure upon the epigastrium, as a rule, causes pain at the onset of the disease. The gall bladder is sometimes tender on pressure. Lastly, on auscultation of the chest one can often hear dry or moist sounds, indicating bronchitis.

Soon, however, the typical picture of enteric fever begins to appear.

The headache, which is chiefly frontal, gets more severe during the next few days. The patient feels giddy when he wants to raise his head or sit up in bed. He is restless in his sleep and suffers from nightmares. The spleen increases in size at the sixth or seventh day. Lastly, the temperature gradually rises. It goes up every evening without returning in the morning to the point at which it was on the previous morning. This is the period of ascending oscillations. The pulse does not keep parallel with the temperature, but is more rapid in the evening than in the morning, and becomes dicrotic.

Such is the ordinary clinical picture of the first period, which lasts from about four to seven days.

Height of the Disease.—In a second period which lasts on the average from a week to a fortnight, and sometimes more, the clinical picture becomes more definite. The temperature falls but slightly in the morning and keeps at about the level of 104° F. The pulse becomes frequent, soft and compressible. The headache diminishes, but the patient is prostrate and his facies becomes characteristic. During the daytime he is indifferent to persons and things, his intelligence appears less on the alert, he is slower in

replying and he is somnolent. But as soon as the evening comes he begins to be delirious, gets restless, has subsultus tendinum and carphology. After waking up in the morning he sinks back into the state of stupor (*τῦφος*), which has given its name to the disease. At the same time the tongue becomes dry and brownish at the base and centre, and increases in length, and the epithelial covering disappears at the tip and edges, which assume a glazed and red appearance, intersected by fissures which are sometimes quite deep.

The lips are dry and cracked, and the teeth covered with sordes. Throughout this period careful examination of the abdomen shows some small isolated spots, circular in shape, with definite outline, pink in colour, slightly round above the skin, disappearing for a moment on pressure, but soon reappearing. These lenticular pink spots are also present in very variable numbers on the chest and sides of the thorax.

One may also find ulcers present in the pharynx, the so-called Duguet's ulcers.

The skin is dry, but in the morning it is sticky and damp. Sometimes it is covered with "sudamina." The diarrhœa becomes more fœtid, the stools more frequent, the meteorism more pronounced; while the pain caused by pressure on the iliac fossa is severe enough to "cause the face of a comatose patient to contract" (Jaccoud).

The spleen grows larger and often passes below the false ribs.

The sphincters are sometimes relaxed, and the bladder is occasionally sluggish. The patient loses flesh considerably and gets weaker.

Death may occur in coma or the patient may gradually become convalescent.

Period of Defervescence.—The temperature falls either suddenly, which is rare, or rather slowly and gradually. In the first case "this sudden defervescence is complete in twelve hours, between the evening of one day and the morning of the next, or at the latest in thirty-six hours. The decline of the fever is accom-

panied by a complete change in the outward appearance of the patient : his facies becomes bright and assumes a normal expression. The organic recovery takes place quietly ; the phase of repair being reduced to a minimum and accomplished uneventfully, truly speaking, forms a part of convalescence " (Jaccoud).

In the second case, which is much more frequent, defervescence takes place gradually, by lysis. The temperature drops at first some tenths of a degree each evening, and then, having reached 101·8° or 102·2° in the evening, it falls to normal in the morning. This is the period of descending oscillations. The evening temperature also gradually becomes normal and remains so.

While the gradual fall of the temperature takes place in this manner, the patient comes to life again, as it were. The stupor disappears, the delirium subsides, the somnolence ceases, and he recovers consciousness of his condition and surroundings. The tongue, gums and lips become clear, the diarrhœa disappears, and very often gives way to constipation ; the meteorism diminishes, more urine is passed, the spleen resumes its normal dimensions, sleep returns, the appetite revives, and improvement takes place daily until recovery is complete.

Such in outline is the clinical picture of the typical form, and perhaps the most frequent form, of typhoid infection. This *ordinary form of typhoid fever* has special features which may be resumed as follows—

1. *Period of incubation* of varying length, usually two weeks, passing as a rule unnoticed, or brought into prominence by some malaise without specific character, and a very slight rise of temperature.

2. *Period of invasion or onset*, characterised by signs common to every infection : prostration, dizziness, vertigo, frontal headache, pains in the limbs and back ; coated tongue, sticky mouth, anorexia, nausea, occasionally vomiting, thirst, constipation, epistaxis, pain in the right iliac fossa, swelling of the spleen, and a special form of temperature (ascending oscillations).

3. *Height of the disease.*—Absolute anorexia, caked tongue, dry lips, pronounced meteorism, gurgling, diarrhœa and urine with special features, enlargement of the spleen, lenticular rose spots, typhoid state, delirium usually of slight degree, stupor, dicrotic pulse, temperature at a high level and excessive loss of flesh.

4. *Period of defervescence.*—Fall of temperature, sometimes sudden (rare), sometimes by lysis (descending oscillations), polyuria, return of appetite, and disappearance of the various symptoms.

But the disease is far from following step by step the schematic lines of this description, either at its onset or during its course. Sometimes one symptom or group of symptoms dominates the scene; sometimes the general course of the affection is prolonged or curtailed; and, lastly, the special features of an attack, according as it is mild or severe, have given rise to the description of numerous special forms.

From these forms we will select only those whose retention appears specially justifiable.

1. **Forms with Special Onset.**—*Sudden onset.*—Typhoid fever has not always a slow and progressive onset. There are cases where it "explodes," *i. e.* begins suddenly and with great violence. Trousseau and Murchison quote instances of the kind; Vincent has noted the special frequency of these forms in Algeria, among malaria patients.

The patients generally have a violent headache and a shivering attack, with a temperature about 104° F. In some cases there are pains in the joints, nausea and vomiting.

The serum reaction is positive earlier than usual (Widal).

Pneumo-typhoid.—In exceptional cases pneumonia may mark the onset of typhoid fever. The intensity of the pulmonary symptoms may cause one to overlook the signs of typhoid fever, which is recognised only at autopsy. Pneumonia and typhoid fever may be concurrent and both be diagnosed from the first. The pneumonia subsequently subsides and is replaced

by symptoms of typhoid fever, which then runs a normal course. This pneumo-typhoid is regarded by some authorities as the manifestation of the primary localisation of the typhoid bacillus (Gerhardt, Lépine, Grasset, Potain); according to others it is merely a superadded disease (de Marignac, Castex). Laboratory investigations have not yet cleared up this question.

Numerous clinical types have been created based on the predominance of an abnormal symptom, or on the more obvious localisation of the bacillus in a special organ at the onset of the disease.

Thus writers have described a *pleuro-typhoid*, in which the initial pleurisy precedes the manifestation of the signs of typhoid fever by eight to nine days; *arthro-typhoid*, *broncho-typhoid*, *meningo-typhoid*, etc. It would certainly be easy to add to these varieties.

2. Forms in which One or Several Symptoms Predominate.—Here, too, there has perhaps been a needless multiplication of symptomatic types.

The bilious or gastric form, with its bilious symptoms (nausea, bilious vomiting, slight jaundice) indicates the invasion of the bile ducts by the typhoid bacillus. It is frequent in hot climates, and has often been observed in the course of the present war.

Hæmorrhagic form.—All the principal infections may assume the hæmorrhagic form. Typhoid fever is no exception to this rule. In addition to the initial epistaxis, the mechanism of which is unexplained, and the hæmorrhage from the gums or mouth due to ulceration of the gums or mucous membrane, hæmorrhagic nephritis, due to typhoid infection, is also found. Lastly, intestinal hæmorrhage, which is more common, has a special pathogeny with which we shall deal later.

These hæmorrhagic forms may have an epidemic character (Leudet), which is perhaps explained by the activity of the toxins secreted by some strains of the typhoid bacillus.

These hæmorrhages may occur at any period of the disease, in any organ and in all parts of the body:

e. g. skin, mucous and serous membranes, intestine, uterus, lung, meninges, pleuræ, muscles, etc. The temperature is high, the heart fails and the patient is unable to offer any resistance. Death is very frequently the termination of these cases.

3. **Forms with a Shortened or Prolonged Course.**—*Abortive typhoid fever* (*typhus levissimus*). —Under this denomination are included "typhoid febricula of short duration, attenuated typhoid and certain cases of typhoid fever which are severe, but end in rapid recovery before the ordinary period of convalescence" (Letulle). They are fairly often seen in incompletely vaccinated subjects.

This abortive form of typhoid fever is specially found in children and is more frequent in certain epidemics (Letulle). At the onset the temperature may be very high, rising on the evening of the fourth or fifth day to 104° or 104·6° F., and associated with headache and complete insomnia; vomiting is not uncommon, the patient is usually constipated, there may be epistaxis. The rose spots appear from the seventh to the tenth day, but may be absent (Letulle).

The spleen is usually enlarged. The pulse is not very rapid, 70 to 90. The other symptoms are those of ordinary typhoid fever. The temperature may decline gradually to normal, or fall suddenly with copious perspiration. Critical polyuria may occur. These abortive fevers are frequently followed by relapses which are themselves often slight and abortive, but may be severe and fatal.

Prolonged typhoid fever.—In very exceptional cases typhoid fever is prolonged far beyond the ordinary limits. In one of Murchison's cases the appearance of rose spots was noted almost daily from the fourteenth to the sixtieth day. Typhoid fevers have been recorded which have lasted seventy and ninety days. In the so-called *recrudescing* forms the temperature shows a very slight fall, but soon returns to its former level, so that the duration of the disease may be thus considerably prolonged. In other cases the period of

defervescence is very long, but as a rule it is an exceptionally protracted amphibolic stage which prolongs the febrile period.

4. **Mild and Severe Forms.**—Typhoid fever presents all the intermediate degrees between apyrexia and hyperpyrexia; the temperature being as a rule the faithful expression of the severity of the disease.

Insidious or latent form.—Ambulatory form.—This form has been carefully studied by Louis, and Chomel and Louis. The expression, "ambulatory form," designates its special feature; the patient is up and about, and continues his ordinary occupation. In this form the symptoms are generally mild. The patient may have irregular shivers, alternating with flushes and feelings of heat, slight headache and lassitude; the appetite is lost, and sleep disturbed. There may be diarrhœa or constipation. The pulse is sometimes a little quickened, but may remain normal; rose spots may be found, as well as enlargement of the spleen. Fever may either be absent or very high (Jaccoud). Sometimes the ambulatory fever retains its character throughout and ends in recovery without the patient taking to bed. Sometimes towards the twelfth or fifteenth day the typical assemblage of typhoid symptoms appears. Lastly, in some cases the condition suddenly becomes alarming. The patient develops acute delirium or a sudden intestinal hæmorrhage, which may end fatally; or, more commonly, symptoms of perforation appear, with acute peritonitis, which is fatal in a few hours. Sometimes sudden death terminates what seemed to be quite a mild infection. The patient succumbs to myocarditis with stoppage of the heart. This cause of death has often been observed during the present war.

Febrile gastric derangement, synochus or typhoid febricula, belongs to the same clinical category as *typhus levissimus*.

This variety lasts seven to twelve days at most, and then the patient is quite well again. This febrile gastric derangement, which may also indicate a

paratyphoid infection, does not always run a mild course.

A blood-culture may confirm the diagnosis, as in certain so-called *apyretic* cases, in which the patient has no fever and complains only of vague discomfort and shows signs of anæmia and progressive weakness. This last form may be seen in enfeebled persons and subjects of chronic malaria.

Ataxo-adynamic or hyperpyretic form. — The old physicians used to differentiate between an *ataxic form* and an *adynamic form.*

In reality these two symptoms are as a rule associated, and are both accompanied by a high and prolonged temperature.

The ataxia is shown by more or less violent nervous disturbance: delirium, convulsions, subsultus, carphology, etc., alternating with adynamia, *i. e.* prostration, stupor and weakness of the voice. At the same time, feebleness of the pulse corresponding to the myocardial lesions becomes evident. The patient has frequent fluid stools, which are sometimes involuntary, and bedsores. The temperature ranges between 104·8° and 106·6° F., with very slight oscillations between the evening and morning records.

The ataxo-adynamic form with hyperpyrexia is extremely grave. Fulminating cases may occur which commence suddenly with violent headache and delirium, and terminate fatally in a few days.

Typhoid fever may assume special characters according to the state of the individual whom it attacks. The age, previous health, and co-existence of another infection profoundly modify the clinical characters of the disease. We will now study each of these modifications in turn.

Typhoid Fever according to Age

Typhoid Fever in Children. — (*a*) **Infancy.** — Typhoid fever in the infant is rather rare. At this age the diagnosis is peculiarly difficult. According to

Comby and Marfan, typhoid fever is exceptional in the first six months of life; from six months to two years its frequency increases.

Hutinel and Darré state that the principal cause of this immunity is the fact that the child does not leave the arms of its mother or nurse, and consequently is but little exposed to direct contagion. Its mode of feeding may also explain this rarity of infection. When typhoid fever does occur at this age, it is severe owing to pulmonary complications, especially secondary broncho-pneumonia of streptococcal nature, which is fairly often superimposed on the typhoid process.

In the case of a feverish infant one should first of all think of the eruptive fevers, and then of sore throat. The appearance and number of the stools, which are usually very liquid, fœtid, yellowish, sometimes greenish in colour, of porridgy consistence, and twelve to twenty-five a day; the acceleration of the pulse, *without dicrotism;* the appearance of rose spots combined with enlargement of the spleen; the state of prostration or, on the other hand, the infant's incessant cries and restlessness, are symptoms which should suggest typhoid fever. The serum reaction should be investigated.

Typhoid fever in the infant may assume one of three forms.

In the *gastro-intestinal form* the prostration is considerable; the little patient vomits its feeds and loses flesh considerably. The stools are numerous (six, twelve or twenty-five in the twenty-four hours), sometimes glairy (Nobécourt and Voisin). Green diarrhœa is fairly frequent and is accompanied by a high temperature. "This form is terribly fatal," says Marfan, "and as a rule in a few days' time a choleriform enteritis develops, probably due to a secondary infection, which carries off the patient."

In the *meningeal form* the clinical picture recalls that of meningitis: cries, restlessness, vomiting, very rapid pulse, fever without remission, constipation, a wild look, and strabismus. These phenomena of

excitement are succeeded by pronounced prostration. Trousseau's meningeal streak appears. Lumbar puncture gives issue to a fluid under tension, and causes a decided improvement in the little patient's condition. In other cases the reaction is intense; colic, shivering, vomiting, inequality of the pupils, ptosis, very pronounced internal strabismus, Cheyne-Stokes respiration, and death within ten days.

The least unfavourable variety is the so-called *febrile form.*

"A little diarrhœa, prostration, slight nervous phenomena, but nothing striking: the fever is the chief symptom" (Hutinel and Darré). The temperature curve sometimes resembles that of an adult, but as a rule it is rather irregular.

In favourable cases the fall of the temperature takes place slowly by lysis, occupying a whole week.

(*b*) **Childhood.**—Typhoid fever is fairly frequent in the child about seven or eight years of age, but is less severe than in the adult. The duration is also less, a fortnight only on the average, instead of a minimum of three weeks.

Abortive or curtailed forms are frequent.

The onset is often sudden, accompanied by vomiting lasting for twenty-four or forty-eight hours, or appendicular symptoms, or torticollis resembling rheumatic wry-neck. It may also simulate meningitis. In these cases the temperature goes up at once to about 104° F. These high temperatures of 104° and above have not the same severe prognosis as in the adult.

The pulse is relatively slow, 90 to 100 or 110 (Hutinel). According to Thoinot and Ribierre it is more rapid than in the adult (150–180 in very young children; 100–140 in older children).

Persistent constipation is almost the rule, followed by diarrhœa at a late stage. Meteorism is often ill-marked. In some exceptional cases, however, the belly is much distended, diarrhœa develops and becomes profuse. Enlargement of the spleen is almost constant.

Rose spots are more frequently absent in the child

than in the adult. They usually appear from the sixth to the twelfth day. They are sometimes particularly abundant and may become generalised (exanthematic form). The heart sounds may assume the embryocardiac rhythm, the extremities becoming cyanosed. Arteritis is infrequent; phlebitis occurs fairly often. Hæmorrhages, though not harmless, are rarely fatal. Perforation occurs only in children of a certain age. It is manifested by a fall of temperature, abdominal distension, and later by porraceous vomiting. Colitis may mask the onset or occur in the course of typhoid fever. " In that case it is most frequently produced by enemata of boiled water which are not isotonic, and cause the passage of mucus and membrane into the stools. To make matters right again, enemata of mucilage are all that is required " (Hutinel).

In the course of typhoid fever in the child we may meet with meningeal reactions (meningism of Dupré), suppurative meningitis, pyelitis, and pyelonephritis; the last two complications supervening when the child has previously had a renal affection.

Albuminuria is frequent.

Aphasia of transient duration and without verbal deafness has been recorded.

Periostitis, especially of the tibia, is not rare. Otorrhœa is fairly frequent, causing deafness and often deaf-mutism in young children, who forget how to talk.

Besides desquamation and loss of hair, one may observe erythemata in young children, which indicate a severe infection. Such cases present ulceration and fissures of the lips, ulceration of the pharynx, and streptococcal ulceration of the skin. The patient is cyanosed, his temperature shows a sudden drop, the arterial pressure is low, the abdomen retracted, and he lies in a state of profound depression (Hutinel, Loiseau).

These are the grave forms which sometimes assume an epidemic character.

Generally speaking, with the exception of infants, typhoid fever in the child has a more favourable

prognosis than in the adult, and is especially favourable at about the age of ten or twelve years.

Typhoid in the Aged.—Although typhoid fever is rare above 40, fairly numerous examples are to be met with (61, 70, 73, 86, 90 and 100 in a case of Guéneau de Mussy). Its course is then abnormal and the prognosis extremely grave, doubtless on account of the visceral lesions of the heart, kidneys, lungs and arteries, which so frequently accompany old age. "The onset is usually insidious; debility and tremors are often prominent symptoms; the type of the fever is essentially adynamic. Rose spots, acute delirium and urgent diarrhœa are rarely observed. The pyrexia is usually protracted, but the temperature, even in fatal cases, is rarely so high as in younger persons, and more often falls below normal" (Murchison). We may add that pulmonary phenomena play an important part and are frequently responsible for the fatal termination.

Convalescence is always protracted, owing to gastro-intestinal troubles and mental disturbances, such as loss of memory, which is often permanent, or cardiac disorder which fairly frequently terminates by collapse.

Typhoid Fever in Pregnancy.—Pregnancy in itself is not an aggravating factor in typhoid fever. But the disease may, by its effect on the fœtus, cause abortion or premature delivery in about one out of three cases. Advanced pregnancy particularly predisposes to abortion, which may occur at any period of the disease, from the first week till the first days of convalescence (Hutinel).

In the great majority of cases the fœtus is expelled dead; when the child is alive its blood presents agglutinating properties (Widal and Sicard). Death of the fœtus has been attributed to profuse hæmorrhage from the endometrium or to hyperthermia, although this suggestion has not been confirmed.

The presence of specific agglutinins or of the actual typhoid bacillus in the blood (Chantemesse and Widal, Legry, Étienne, Marfan, etc.) or organs of the expelled fœtus, suggests that the fœtus may succumb to the

direct action of the infection transmitted to it by the mother.

Typhoid Fever in the Course of Various Pathological Conditions.—Certain persons who are already suffering from an acute or chronic disease may contract typhoid fever, or an acute infection may be grafted upon an already existing typhoid fever. This combination gives rise to the following interesting clinical forms.

Typhoid fever and acute exanthemata.—Murchison has recorded a case in which typhoid fever was complicated by *variola* and *vaccinia*. Barthez and Rilliet, Taupin, Jenner and Kesteven have seen cases of co-existent typhoid fever and *measles*.

Scarlatina has often been noted in typhoid fever. Usually the patient suffering from typhoid fever is admitted to hospital, where he contracts scarlatina. In a certain number of hospitals, both for children and adults, all diseases are treated in the same ward.

Typhoid fever and diphtheria.—In children's hospitals an attack of faucial diphtheria in typhoid fever may prove fatal in forty-eight hours. The association of diphtheria and typhoid fever often has a grave prognosis in the adult also.

E. Rathery has recorded an epidemic of typho-diphtheria in the army, in which the asthenic cardio-bulbar forms were remarkably frequent. Side by side with these forms there were others, dyspnœic forms of an asphyxial type, as well as laryngeal, broncho-pulmonary and nervous forms of a meningeal type. Rathery regards the peculiar dry state of the mouth in typhoid patients as likely to exalt the virulence of the diphtheria bacillus in the highest degree. Marcel Labbé, who saw nine cases in a month, states that the association of typhoid and diphtheria is shown by an aggravation of the general symptoms, a persistently high temperature, weakness of the heart, a small and feeble pulse, diminution of the urine and coldness of the extremities.

Typhoid fever and tuberculosis.—A tuberculous

patient may contract typhoid fever which develops normally, but in convalescence the tuberculosis may take on a rapid course. It is not exceptional to see a convalescent from typhoid develop undoubted signs of tuberculosis, and even of acute phthisis.

Erysipelas is a grave complication of typhoid fever, but has become rare since more care has been given to the lesions of the skin which are so frequent in typhoid patients.

The occurrence of streptococcal infection, at the onset or in the course of typhoid fever, has formed the object of a special study (H. Vincent), owing to the gravity of its prognosis.

When the streptococcal infection occurs in the first stage of typhoid fever, it may be the cause of disease without any affection of Peyer's patches. The patient succumbs to a veritable *strepto-typhoid septicæmia*, his blood containing an abundance of both micro-organisms. When it appears in the course of typhoid fever, it is much less severe.

Pneumonia may occur during typhoid fever; the pneumococcus is present in the sputum. It may be carried to the meninges and determine an extremely acute meningitis, or an exudative meningitis with a pseudo-membranous investment in which the pneumococcus will also be found.

The *bacillus pyocyaneus* and *proteus vulgaris* may, by secondary infection, invade the blood or viscera of the typhoid patient, but these complications are very rare (H. Vincent).

Cases of cholera (Girode) and tetanus (Rouget) in typhoid fever have been recorded.

In *alcoholic* patients typhoid fever assumes a severe character. At the onset the symptoms are those of an ataxo-adynamic fever without the hyperthermia being excessive. The principal symptoms are delirium, cardiac paresis and ataxia. Hæmorrhages and bed-sores are frequent.

In *diabetic* patients typhoid fever often runs its course without causing much disturbance; the tem-

perature is little raised, and the disease may be mild and almost latent. The glycosuria persists, and the diabetes is in no way modified in its character or evolution.

Typhoid fever is a serious complication in *cardiac*

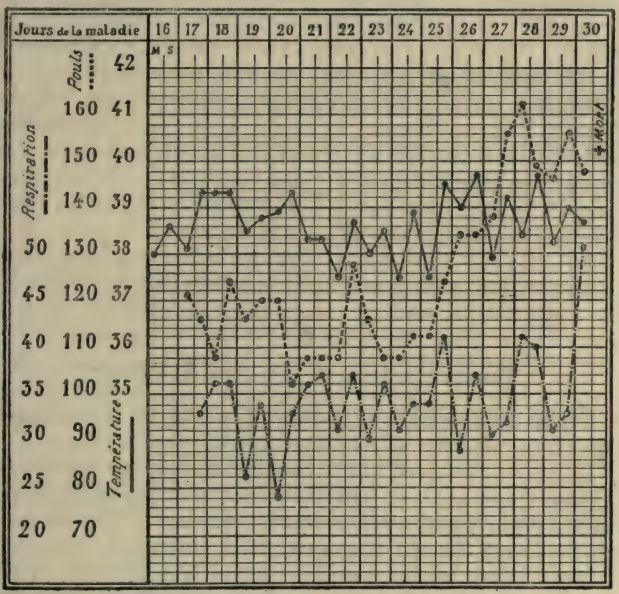


FIG. 1.—Typho-malarial fever. Unusual acceleration of pulse (140–162) after 25th day, myocarditis with embryocardia and death.

and *pulmonary* diseases, the pre-existing lesions being aggravated by the new infection.

Influenza fairly frequently precedes typhoid fever. Potain has drawn attention to the mild character of this post-influenzal fever, whereas Siredey, on the other hand, has seen severe and fatal cases under the same conditions.

Lastly, Kelsch and Kiener and Vincent have

described, under the name of typho-malaria, the association of malaria and typhoid fever in the same individual. (Fig. 1).

In malarial patients the onset of typhoid fever is often sudden, being characterised by a frank attack in the form of a quotidian fever with shivering. But the fever very rapidly becomes continuous. The ordinary severe typhoid symptoms then develop, especially if the malaria is not treated, viz. profuse diarrhœa, lenticular rose spots, meteorism, enlargement of the spleen and adynamic nervous troubles; while the malaria is revealed by enlargement of the liver, the earthy complexion and the periodic or irregular temperature. Sometimes pernicious attacks occur during convalescence and prove fatal.

As regards skin affections (eczema, scabies, hard chancres, etc.) they are only temporarily modified by the typhoid process.

Termination of Typhoid Fever

Death may occur at various periods of the disease, but rarely before the fourteenth day.

In hot countries, and also in overwrought soldiers, in war time, it is not exceptional to meet with death on the eighth and even on the sixth day of the disease, death being due to the hypertoxic forms.

Death may be the consequence of the severity of the infection; of localised complications, such as peritonitis, intestinal perforation, rupture of the gall-bladder, intestinal hæmorrhage, myocarditis, nephritis, etc.; of superadded infections, such as streptococcal or staphylococcal septicæmia, pneumonia, broncho-pneumonia, diphtheria, etc.

It may occur suddenly without a cry, a movement or a complaint of any kind. This sudden death, which is not uncommon (1 to 3 per cent. of the cases) most frequently takes place in the third week. It has been attributed to various causes, *e. g.* an intestinal reflex (Dieulafoy), degeneration of the myocardium

(Hayem), cardiac thrombosis (Marvaud), cerebral anæmia (Huchard, Laveran), pulmonary embolism, neuritis of the cardiac plexus, profuse intestinal hæmorrhage, etc. Myocarditis seems to have been one of the most frequent causes of rapid or sudden death in the present war. During the Tunis expedition one typhoid patient out of six succumbed suddenly (Czernicki).

The percentage mortality varies and is subordinate to the age, sex, nature of the treatment, degree of gravity of certain epidemics, climate and previous condition of fatigue or overwork.

In childhood the mortality is only 3 to 5 per cent., sometimes it is lower still. In the adult the average is 11 to 14 per cent.

In the aged the course of the disease is more rapid, and death is very common. The mortality in women is lower than in men.

The rational employment of cold baths has appreciably diminished the gravity of the infection, and the number of deaths. Some epidemics, however, are remarkable for a high mortality, and others for their milder character, which indicates the varying pathogenic power of the different strains of the typhoid bacillus, as is the case with the bacilli of dysentery, cholera, etc. In hot countries the case mortality is considerably higher than in cold or temperate climates, either because the external temperature adds its own influence to that of the fever, or because the micro-organisms are more toxic.

Lastly, in patients in broken-down health, or who have come under treatment late, or who have been overworked, the mortality may be as high as 20 and even 25 per cent. The state of war greatly predisposes to a grave prognosis in combatant soldiers, among whom the mortality is very high.

Recovery only takes place after a more or less protracted period of *convalescence*, which may be normal or *complicated*.

" Convalescence can only be said to be fairly estab-

lished when the temperature is normal on two successive evenings " (Murchison). But it is still very unstable. By the time convalescence begins the patient has become very thin, the loss of weight sometimes amounting in the course of the disease to 200–300 grammes per day, and even more. His skin is of a peculiar colour : " he has the face of a starved man " (Hutinel). His cheeks, hitherto coloured by fever, become decidedly pale. His pulse is irregular, is quickened by the slightest effort, an insignificant emotion, or the doctor's visit. The appetite returns, however, and is truly ravenous. The urine, after the transient polyuria and chloride discharge, becomes normal again in quantity, and poor in chlorides and urea. The muscular system is weakened, walking and standing are difficult and painful, the patient is quickly tired but recovers his strength gradually. The skin peels, the nails present furrows and depressions, the hair falls out but grows again as repair takes place, the weight increases and the anæmia disappears.

Some convalescents will be found to have lost their memory and present disturbances of hearing, taste and smell; they are very impressionable, and sometimes show temporary modifications in their character (excessive apathy, starvation delirium or irritability). As a rule, however, the disappearance of fever is accompanied by a marked sense of well-being.

The duration of convalescence varies considerably, being more rapid in children and longer in adults above forty years of age.

There are few cases of typhoid fever in which the disease or convalescence is not interrupted either by some slight incident or grave complication.

Typhoid fever is pre-eminently a disease with complications.

Venous thrombosis is a fairly common occurrence in convalescence, being due to the growth of the staphylococcus, and in exceptional cases of the streptococcus, in which case the prognosis is very grave. Typhoid arteritis is rarer. Convalescents sometimes

suffer from obstinate vomiting, which may become uncontrollable and even be the cause of death.

Cachectic diarrhœa may persist indefinitely and considerably weaken the patient. Paralysis from neuritis, abscesses and boils are not rare. Some convalescents may show œdema without albuminuria, which clears up in two or three weeks, and the pathogeny of which is still obscure. After long and severe illnesses bedsores may be the starting-point of septicæmia, which is sometimes fatal. The temperature *ought* to be normal in convalescence, but the thermometer may rise for some hours under the influence of fatigue, emotion, excess of food or a meat diet (*febris carnis*).

When the rise of temperature lasts for more than a day it becomes the first symptom either of an intercurrent complication (phlegmasia alba dolens, osteitis, various suppurative lesions, etc.) or of the interruption of convalescence by a relapse.

Relapses

By a relapse of typhoid fever should be understood a second evolution of the specific febrile process after convalescence from the first attack is fairly established. Relapses should not be confounded with recrudescences, which are common during the period of ulceration, nor with second attacks.

Recrudescences are aggravations of the typhoid symptoms which usually occur in the period of defervescence. The disease "rebounds," so to speak, and when it appears to be on the way to convalescence, it breaks out again.

A *relapse* is a revival of typhoid fever in actual convalescence; that is to say, when the patient has had a normal temperature for several days.

The *second attack* is a fresh attack of typhoid fever occurring a very long time after recovery from the first. Although as a rule the first attack confers immunity, this immunity may be attenuated or lost

after a varying period of time, thus rendering possible a fresh typhoid infection.

The relapse begins from eight to thirty days after the termination of the febrile cycle (Jaccoud); as a rule, however, it does not develop after the end of the first fortnight. It may start after an apyrexial period of from one to three days.

It reproduces completely and in their normal order all the symptoms of typhoid fever.

The first symptom is the rise of temperature, which may occur just as at the onset of typhoid fever, viz. either suddenly or by more or less pronounced ascending oscillations, with or without shivering. The ordinary symptoms reappear. The eruption of rose spots appears earlier than in the first attack.

The duration of the second attack is usually, but not invariably, shorter than that of the first. As a rule, the relapse is fairly mild. The severity of the relapse has no relation to that of the initial disease. In a third or quarter of the cases the symptoms are severer than in the first attack. The relapse is not always single. Cases of typhoid fever with multiple relapses have been seen, *e. g.* two (Trousseau, Stewart, Maclagan), three (Bucquoy, Jaccoud, etc.), four (Hallopeau), and even five relapses (Jaccoud). Perhaps the last was a case of Malta fever.

Sequelæ of Typhoid Fever

In the majority of cases recovery from typhoid fever takes place without any sequelæ.

Typhoid fever may, however, leave behind lasting traces of its visit in the form of disablement and chronic visceral lesions, or pathological states which appear during the fever and continue their course after the fever has ended.

Writers have recorded cases of prolonged and even permanent enfeeblement of the memory, slowness of perception, difficulty in the formation of ideas, disturbance of speech, and in children and young persons

" a lowering of the intelligence, which increases through want of exercise, and may end in a condition bordering on imbecility " (Jaccoud).

Acute mania, melancholia, megalomania, religious mania, etc., have been observed as the results of typhoid fever.

Polyneuritis, disseminated sclerosis, chorea and anterior poliomyelitis have been recorded.

Nephritis is rather rare; paratyphoid appendicitis has been described by Dieulafoy.

Prolonged infections of the bile ducts, and some forms of biliary cirrhosis may be attributed to a previous typhoid infection, owing to growth of the bacillus in the gall-bladder and bile ducts.

There are many cases on record of osseous and articular lesions, such as hip-joint disease and coxo-femoral dislocation, as well as mutilations of the extremities following gangrene due to arterial obliteration. Lastly, in the antecedents of patients suffering from leukæmia, Hodgkin's disease (Reynaud), and splenic pseudo-leukæmia, typhoid fever has been noted, without, however, any demonstration of the relation of cause and effect between these diseases and the typhoid infection.

CHAPTER II

CLINICAL CHARACTERS OF TYPHOID FEVER
(*continued*).

Analysis of Symptoms and Complications according to their Anatomical Situation

Digestive System

The symptoms presented by the digestive organs in typhoid fever are most important. Except in the mild cases, where the patient preserves it throughout the disease, the *appetite* is already declining in the incubation period and is completely lost at the height of the disease, to reappear again in the course of defervescence, when its demands are imperious and dangerous.

According to Vaquez, the anorexia is mainly due to the insufficient diet to which the patients are restricted.

Thirst is complained of. There is a bitter taste in the mouth. The salivary secretion is diminished. The restricted diet, fever and *diarrhœa* are factors in the diminution of these secretions. P. Merklen and Milhit, however, have reported a case of abundant ptyalism followed by sialorrhœa, with painless bilateral parotid and submaxillary swelling.

At the onset and during the first few days of the disease the tongue may be broad and flabby, and show the marks of the teeth at its edges. It soon becomes narrow, tapering and more or less pointed. The epithelial covering disappears at the tip and edges, so that the central part, which remains white or yellowish white, is surrounded by a bright red zone placed like an isosceles triangle with its base posteriorly. In

other cases, on the contrary, the coating disappears from the centre of the organ, which then projects like a red V into the middle of the white zone (Jaccoud). When the course of the disease is normal, and devoid of gravity, the tongue retains this appearance. When the disease lasts longer and assumes a more severe form, the redness of the tip and edges becomes more marked, a red punctation appears at these points and the central coating gets thicker. Lastly, in the grave forms with a severe "typhoid state," the tongue gets dry and assumes an appearance which has given it the name of "roasted tongue," "grilled tongue," or "parrot's tongue." It becomes retracted, hardened and shrivelled, its movements are difficult, uncertain and painful. Its thick coating becomes brown or blackish, crusted and cracked; it is formed by dried epithelial cells and mucus, and coloured by the blood which has oozed from the cracks. The lips become dry, cracked and covered with sordes. When the typhoid state is established the teeth become covered with a similar coating. In very rare cases the gums are the seat of hæmorrhage.

The soft palate, uvula, tonsils and pharynx take on a red tint and become covered with a brown coat.

In severe attacks various forms of sore throat are seen as complications, such as tonsillitis, diphtheria and gangrenous angina.

Thrush is fairly often observed. It appears on the soft palate, sometimes on the back of the pharynx, almost always on the pillars and tonsils, rarely on the cheeks and tongue, and hardly ever on the gums and lips; sometimes it covers the uvula, and is accompanied by extreme dysphagia. It yields to treatment, but recurs with an exasperating obstinacy.

R. Tripier, Devic, Johanno, Letulle and others have dwelt on the appearance of bucco-pharyngeal *ulcerations* in typhoid fever. These isolated or multiple ulcerations, apparently due to local infection by the pathogenic flora of the mouth, may be found on the tongue, lips and cheeks, soft palate, uvula, in the

gingivo-labial fold and at the frænum, and, in exceptional cases, on the posterior pillars.

In addition to these ulcerations there are others, noted for the first time by Bouveret in 1876 and called "Duguet's ulcerations." They are to be seen in one out of five cases. They really constitute a symptom and not a complication of typhoid fever. Their seat of predilection is on the anterior pillars of the palate.

They are fairly often situated symmetrically on the two palatal pillars, where they appear in the form of a whitish or ashy grey patch, slightly oval in shape, running obliquely downwards and outwards, with their long axis parallel to that of the corresponding pillar, and measure six to eight mm. in diameter. On their surface is to be found a little mucus, which is easily removed, leaving an almost normal mucous membrane which does not bleed, is not indurated, and is of a yellowish grey or grey pink colour. The ulceration is shallow, its edges are regular and surrounded with a small red area of congestion.

On the edges of the tongue may be seen ulcers of a different appearance, as they are deeper and their edges are sharply cut. The mucous membrane surrounding them is swollen and bleeds readily. They are specially situated at points which are subject to pressure or the action of the teeth, whether in the dorsal or lateral decubitus.

They are kept up by the dryness of the mouth and prolonged immobilisation resulting from the rarity of movements of mastication and deglutition, and lastly by the local infection caused by the microbial flora of the buccal cavity. They are absolutely painless, have hardly any effect on the neighbouring lymph glands, and are most frequently met with in severe forms of typhoid fever.

The ulceration of the palatal pillars appears before the beginning of the second week, at the same period as the lenticular rose spots.

They are characteristic enough to confirm a diagnosis of typhoid fever.

Very rare cases occur in which, apart from the fever, the only symptom referable to the digestive tract has been this ulceration of the pillars, the patients having had no meteorism, diarrhœa or nervous symptoms. As they generally disappear at the same time as the fever, they serve to a certain extent as a guide to the course of the disease. Their persistence may herald a relapse; while their disappearance, even if it does not eliminate the possibility of a relapse, is of favourable prognosis, the relapse being usually mild (Devic).

The practical importance of looking for these ulcers is obvious, possessing as they do the value of a specific sign, with the exception of the lingual ulcers, which have been noted in other acute diseases.

Louis has described pharyngeal ulcers which appear late (third or fourth week); they are multiple and deep, and situated at the lower part and sides of the pharynx, where they cannot be seen by the unaided eye. Their course is generally insidious, but they may be the starting-point of more serious complications, especially retro-tonsillar or retro-pharyngeal abscesses. They may also cause œdema of the glottis.

Gastric Symptoms.—Pain and tenderness on pressure on the epigastrium are very frequent, especially at the onset. They may or may not be accompanied by vomiting.

It is also at the onset of typhoid fever that vomiting is observed in the adult, and still more frequently in children.

It is caused by a feed or a dose of medicine. As a rule the patients have a sense of fulness and tension, with nausea and distaste for food. At the height of the disease uncontrollable vomiting may be caused by the absorption of very small quantities of fluid, and may even be complicated by hæmatemesis.

When it occurs in convalescence, vomiting may merely be a sign of indigestion, or herald a relapse. It is rarer in patients who have not been subjected to a rigorous diet throughout the febrile period (Jaccoud). The best treatment at this time is to give them solid

food (Trousseau). Less frequently the vomiting is due to ulcerative lesions of the stomach and degeneration of the glandular cells of the epithelium, which have not retained, or have been unable to recover, the integrity of their functions.

Intestinal Symptoms.—Abdominal pain and tenderness are frequent but not constant symptoms. They are rarely spontaneous; pressure over most of the intestine is painless, but on the right iliac fossa it causes almost always a characteristic pain, sometimes severe enough to provoke a grimace, a cry or a movement of defence on the part of the patient, however prostrate he may be. This symptom is a more or less early one; it may persist until convalescence, or reappear at that period as the result of constipation or an error of diet. The pain may be found especially at MacBurney's point, and reveals the share taken by the ileum and appendix in the localisation of the infective process.

Meteorism is almost constant. It may be present from the onset, but as a rule it is not definitely appreciable before the end of the first week, and becomes marked in the course of the second. When the intestine contains only a little gas, the abdomen assumes a special shape. It is distended transversely. The umbilicus is very often seen to project. The consistency is elastic on palpation; the resonance of the abdomen is exaggerated on percussion. In extreme cases, with an enormous quantity of gas in the intestine, the intestinal distension becomes generalised, the thorax becomes broadened at the base, the respiratory action of the diaphragm is interfered with, and a more or less serious pulmonary stasis ensues. The frequency and intensity of the meteorism are related to the gravity of the disease (Jenner, Louis, Murchison).

Gurgling.—In a large number of cases a more or less marked gurgling is observed when pressure is made abruptly in the right iliac region. This examination should be made with great care, for any injury to a distended and ulcerated intestine should be avoided.

A good and prudent method of investigating the presence of gurgling is to employ bimanual palpation, using each hand in turn.

According to Jaccoud, gurgling merely indicates that the patient has, or has just had, diarrhœa. It possesses diagnostic value only when it is accompanied by other specific symptoms, and if the patient has no diarrhœa, and has not been given an enema or a purgative.

"Diarrhœa is the rule in enteric fever and constipation the exception." Murchison's formula is perhaps too absolute. Although one may have observed certain cases of an ambulatory type in which the patients complained of diarrhœa only, the date of appearance and duration of the diarrhœa are so variable that this symptom is of little help in diagnosis. It serves, however, to confirm the diagnosis in certain cases by the special characters which it presents.

The diarrhœic stools in typhoid fever are liquid and of yellow ochre or melon-juice colour. They leave a yellowish stain on the sheets, surrounded by a broad zone of a faint pink colour. Their reaction is alkaline, their odour sometimes fœtid and sometimes musty. On standing they leave a flaky sediment, and may contain blood. Their evacuation is not accompanied by colic or tenesmus.

Diarrhœa may be present from the onset of the disease, but usually the patient is constipated. After a purgative the stools are mashy and unformed, and rapidly become liquid. Their frequency is very variable according to the patient. Usually they are not very numerous at the onset (three or four in the twenty-four hours), and the maximum number is reached towards the middle or end of the second week, when they may amount to ten, twelve or twenty in the twenty-four hours. In such cases, which indicate the severity of the infection and are related to the gravity of the disease, the diarrhœa may become an actual danger owing to the amount of water which it removes from the system. The patient's face grows pale, his

features are drawn, his skin grows dry, his peripheral temperature falls, his pulse becomes frequent and small, and collapse may ensue. The discharge of fæces may be involuntary, indicating a profound state of prostration, and causing an erythema of the buttocks and over the sacrum.

The diarrhœa usually disappears at the end of the fastigium or at the beginning of convalescence. It is not exceptional, however, to see it cease rapidly and be replaced by an obstinate constipation, which lasts until the end of the fastigium. Then, as a rule, the diarrhœa returns, and sometimes continues till the end of convalescence.

In very rare cases constipation is more persistent and lasts throughout the disease.

Intestinal hæmorrhage.—Intestinal hæmorrhage is an important symptom. It may be one of the *early* signs of a special form of typhoid fever called *hæmorrhagic.* It is then of a severe prognosis. Sometimes it is slight and appears towards the tenth or twelfth day of disease. But more frequently it results from the opening of an arteriole in an ulcer or erosion of a vessel by separation of a slough, in which case it occurs towards the fifteenth or twentieth day. It may be later (thirty-third, forty-fourth, forty-ninth day). It is rare in the child, uncommon in the adolescent (twelve to fifteen years), and is more frequent in the adult and in certain epidemics. Diabetes preceding typhoid fever seems to predispose to hæmorrhage, owing to the arterial hypertension which is the rule in diabetes (Teissier).

Late hæmorrhage, especially that occurring at the end of the third week, appears with equal frequency among patients with diarrhœa or constipation. The quantity of blood lost may vary from a few drops to several litres. Sometimes the intestinal hæmorrhage is fulminating, and causes death before blood has appeared in the stools.

In such cases one may be guided by a sudden fall of temperature, a syncopal attack, an almost instan-

taneous decrease in the size of the spleen, a transient rise of the blood-pressure (Teissier), an increase in frequency of the pulse (Trousseau), and a disappearance of dicrotism of the pulse (Bouchard).

But as a rule the blood appears externally. When it is scanty, microscopical examination is necessary to reveal it. Spectroscopical examination must also be employed when this method is possible. The phenolphthalein reaction (Meyer's reaction) is too uncertain, and should not be recommended (Hugounencq-Labat). The same applies to the reactions with benzidine and tincture of guiacum.

The blood often appears in the form of red streaks. When present in larger quantity, it gives the stools the crimson appearance of normal blood; or, if it has been some time in the intestine, its colour changes to that of sepia, pitch or tar.

The general symptoms of intestinal hæmorrhage vary considerably, according to the quantity of blood lost. In the case of small hæmorrhages there are no symptoms.

When the loss of blood is greater, or the hæmorrhage is moderate in amount but repeated, the patient becomes pale and complains of giddiness, ringing in the ears and tendency to syncope. The temperature falls in proportion to the amount of the hæmorrhage. But this fall is only temporary, and the thermometer soon rises to a higher level than before the fall. Late hæmorrhages often indicate a fatal prognosis (30–35 per cent.), with rapid termination; in an hour in one of Trousseau's cases, and even in a few minutes (H. Vincent). Though some writers have regarded intestinal hæmorrhage in typhoid fever as a favourable symptom, actual facts and statistics prove, on the contrary, that it is a serious symptom, since 44·3 per cent. of the patients with this symptom succumb (Homolle).

Intestinal Perforation.—Intestinal perforation in typhoid fever may be single or multiple, and occur in mild, ambulatory forms as well as in severe attacks, and more rarely in the course of relapses. Their seat

of predilection is the ileum in its last 40–50 cm., especially in the neighbourhood of the ileo-cæcal valve, the appendix and large intestine as far as the rectum.

Perforation is more frequent in men than in women. It is rather rare in children. It occurs generally at the end of the second week, or in the course of the third, and even later. The efforts which patients make in raising themselves or using the bedpan are sometimes responsible for it.

Intestinal perforation is often heralded by premonitory signs, to which some writers attribute very great value and others very little.

Triboulet thinks that profuse diarrhœa accompanied by blood, even in slight traces, has a very great importance in enabling one to foretell intestinal perforation.

Meteorism should be interpreted with much reserve, for perforations have been seen to occur in collapsed intestines, and, on the other hand, very pronounced abdominal distension has been seen when there was no perforation (Cassaët and Duperié).

Intestinal perforation is revealed by peritonitis, which may run its course in one of two ways : acute or hyperacute peritonitis, or peritonitis with attenuated signs, and even latent peritonitis. In the majority of cases the onset is sudden and unexpected. The patient feels a very violent spontaneous pain which compels him to cry out, and may even make him lose consciousness. Without any obvious cause he feels a tearing or stabbing sensation in the lower part of the belly on the right hand side, which may radiate along the spermatic cord to the testicle and rectum and then become generalised. Sometimes the pain is less violent. It may be confined to a rather painful spot, over which slight hyperæsthesia is found on palpation.

Usually there is muscular contracture, which is at first localised to the lower part of the recti, especially the right rectus, and then rapidly extends all over the abdomen, which may assume a board-like hardness and show a scaphoid retraction. The patient usually has a severe attack of shivering; his face is drawn,

his voice lost, the nose pinched, his eyes sunken and surrounded by dark rings, and the extremities cold. The temperature shows a sudden drop, falls even below normal (Fig. 2), and remains so in the cases that are

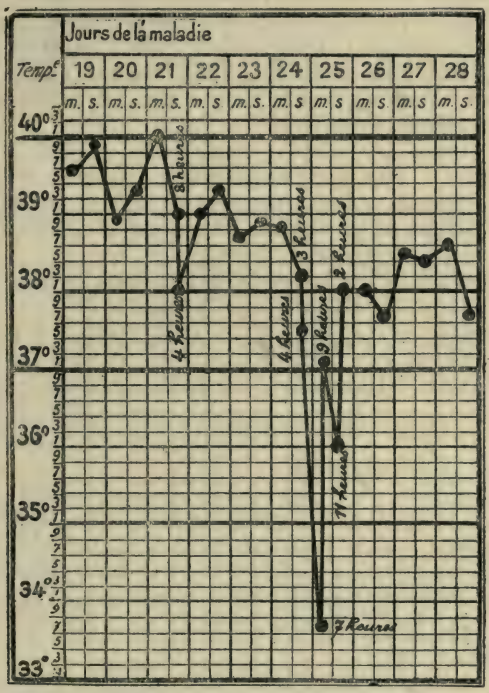


FIG. 2.—Hospital orderly. Typhoid fever, 25th day of disease. Signs of perforative peritonitis. Cyanosis, hypothermia. Temperature 92·6°. Recovery without operation.

rapidly fatal, or rises again a few hours later, but slowly and hesitatingly, in a very different way from the sudden ascent observed after intestinal hæmorrhage. This hypothermia is, unfortunately, not constant, being sometimes replaced by hyperthermia. Lastly, in some

cases the onset of peritonitis is not accompanied by any change of temperature.

The pulse may become frequent, small and feeble, or, on the contrary, become slow. The patient may have nausea and bilious vomiting, which is sometimes green and porraceous and appears early or late. There may be hiccough; micturition—when anuria is not present—may be painful. This vesical pain, which has been noted by Sieur, Picqué and Delbet, is a good sign if it occurs regularly.

The stools are much diminished, if not actually suppressed. This symptom, which has been noted by Sieur, although a late one, has all the more value, as at the period of perforation typhoid patients usually have numerous stools.

Inspiration of the costal type has been noted, as well as disappearance of the liver dulness.

According to Levaschoff, on auscultation a peculiar sound is heard due to the passage of gas into the abdominal cavity. Brown's signs have been rarely met with, and their investigation may be extremely dangerous for the patient. We will mention them, however, for the sake of completeness.

(*a*) The patient lying in the dorsal decubitus, one finds by palpation the point at which the maximum pain is felt. This point having been determined, if the patient be made to lie on his left flank, the painful spot becomes displaced at the same time as the intestinal mass, being shifted from $1\frac{1}{2}$ to 2 cm. in twenty to thirty minutes.

(*b*) If a stethoscope be suddenly applied to this point, fine crepitations are heard which indicate a localised peritonitis.

The sudden appearance of hyperleucocytosis in the blood is inconstant.

It is thus clear that there is no constant sign of intestinal perforation. We may, however, say with Faisans and Flandin that "we ought to think of perforation of the intestine when a pain occurs without any definite reason in a typhoid patient in the third

week, whether it be a stabbing pain or a dull pain, and whether situated at the umbilicus or in the right iliac fossa." The presence of certain other symptoms will confirm the diagnosis ; but one should always remember that perforation may be insidious and develop almost without symptoms, and that " the advent of perforation may likewise be latent in consequence of the patient being delirious or unconscious ; the prostration being accounted for by the severity of the fever, and the ordinary symptoms of peritonitis being absent " (Murchison).

Spleen

Enlargement of the spleen is almost constant. It begins in the middle of the first week and increases until the end of the second. It is an acute enlargement of infective origin, which may be accompanied by abscesses and hæmorrhages into the parenchyma, and, in exceptional cases, end in rupture of the organ. At first the spleen is firm and hard, but later it becomes soft and diffluent.

How are we to examine the spleen, and when can we say that it is increased in size ? Normally it is situated behind the border of the false ribs, and is not accessible to palpation. Its outer and convex surface corresponds to the ninth, tenth and eleventh ribs. Its anterior border is thin and does not pass beyond a line drawn from the sterno-clavicular joint to the anterior extremity of the eleventh rib (sterno-costal line). It may be examined by percussion and palpation, which should always be carried out gently. The enlargement is more readily detected on percussion than on palpation. Percussion should be made gently with little taps and concentrically, starting from a sonorous region towards the zone presumed to be splenic, keeping the ear close to the percussing finger. In practice a spleen should be considered large which measures more than 5 cm. in the largest diameter of its dulness. It may reach nine, ten or twelve cm. and more in its largest axis.

Respiratory System

The *respiratory movements* are usually accelerated, apart from any pulmonary complications. They generally vary with the pulse and temperature.

The *nasal fossæ* are dry; *epistaxis*, varying in frequency and gravity, may occur at any period of the disease. Apart from cases in which it is only one of the manifestations of hæmorrhagic typhoid fever and those which are of exceptional gravity owing to its profuseness, epistaxis has no prognostic significance.

Typhoid fever very frequently causes lesions of the *larynx*, the two commonest of which are ulceration of the epiglottis and laryngo-typhoid. The patient usually has a little hoarseness or aphonia, with dysphagia, especially if the epiglottis is the seat of the ulceration, and the larynx is more or less tender on pressure.

In the course of ataxic or adynamic fevers with bedsores and multiple abscesses, more important lesions are found, consisting in necrosis of the larynx, or *laryngo-typhoid*. After a period of hoarseness the voice becomes weak, the respiration noisy and difficult, and deglutition painful. The patient has a hoarse and toneless cough, and cannot speak above a whisper. All these symptoms become rapidly more pronounced. The cough becomes croupy, the expectoration purulent, or blood-stained, and may contain fragments of necrosed cartilage, the breath is fœtid, the dysphagia increases, and pressure on the larynx is intolerably painful. Respiration becomes more and more difficult and is accompanied by a noisy, guttural rhonchus, which is sometimes "deadened, or rough and harsh like the sound of a bass string" (Bouillaud). Then occur an attack of suffocation with cyanosis, cold and clammy sweat, terrible anxiety, and cardiac failure. The attacks may be repeated, being provoked by the mere application of a tongue depressor or laryngoscopic mirror, or the absorption of a small quantity of fluid. In the intervals between the attacks the patient is in a

state of asphyxial collapse. In spite of a continuous dyspnœa, the suffocative attacks may be absent during the day, as an effort of the will is sufficient to maintain respiration, but at night during sleep, when the will is no longer active, the attacks begin.

The patient may die in an attack, or as the result of a sudden spasm of the glottis.

If he escapes death by asphyxia, he may have abscesses in the neck, necrosis of the cartilages, perilaryngeal phlegmons, etc.

Bronchitis is very frequent in typhoid fever. It generally appears at the end of the first week, and is revealed by sibilant *râles* mixed with a few mucous *râles* scattered here and there throughout the chest, but predominant at the bases. The cough and expectoration have no special characters. Sometimes the lesions of bronchitis are complicated by a slight degree of *pulmonary congestion*, with spasmodic cough and dyspnœa.

At the height of the disease, towards the third or fourth week, there may be *engorgement* and *splenization of the bases* without definite physical signs.

Pulmonary œdema may also be found, indicating typhoid nephritis. But the most frequent pulmonary complication is undoubtedly *broncho-pneumonia*, which may be present in 7 per cent. of the cases (Joffroy), and even 11 per cent (Nobécourt and E. Peyre).

Usually a late event, it develops insidiously, and should always be regarded as serious owing to its possible modes of termination, viz. extension of the process, phenomena of infection, suppuration and gangrene.

Pneumonia rarely occurs before the third or fourth week. In rare cases it may appear sooner and be taken for the initial disease. It has been described under the name of *pneumo-typhoid.*

At the height of the disease pneumonia singularly aggravates the condition of the typhoid patient. In convalescence it has not the same significance, as a rule.

Simple hæmorrhagic infarcts are fairly frequent; foci of pulmonary apoplexy are revealed only by hæmoptysis.

Lastly, *embolism of the pulmonary artery, multiple abscesses and pulmonary gangrene* have been recorded.

Pleura.—Pleural complications are far from rare in typhoid fever (2–4 per cent. according to E. Joltrain and G. Petitjean). They are even more frequent than is supposed, if they are looked for methodically. They may be observed at the onset of the disease, and they constitute that special form which has received the name of *pleuro-typhoid.*

But it is at the height of the disease, and especially in convalescence, that they usually appear.

Dry pleurisy in typhoid fever has no clinical history. *Serous pleurisy* chiefly occurs at the onset.

Cytological examination of the centrifugalised fluid shows an abundance of desquamated endothelial cells and neutrophil polymorphonuclears or eosinophils. In some cases the number of lymphocytes is very high and indicates a latent tuberculous infection, which has been made active by the typhoid bacillus (H. Vincent). Cultivation of the pleural fluid often shows the typhoid bacillus.

Hæmorrhagic pleurisy may be observed at the beginning of convalescence. It is due either to latent tuberculosis or to special virulence in the strain of the typhoid bacillus.

The last view seems to be confirmed by the fact that pure cultures of the typhoid bacillus injected into the pleura of guinea-pigs have produced an abundant hæmorrhagic effusion. Pleurisy may be hæmorrhagic from the first, and then purulent, and finally hæmorrhagic again. When it is localised it may be hæmorrhagic in one part with a B. coli of attenuated virulence, and purulent in another part with the typhoid bacillus (Macaigne and Théry).

The effusion is scanty as a rule and situated on the left. Its appearance and development are generally insidious, without pain in the side, dyspnœa, or rise

of temperature, and the diagnosis can be made by exploratory puncture only.

In addition to the presence of a large number of red cells, lymphocytes or neutrophil polymorphonuclears, which vary in number according to the case, cytological examination of the hæmorrhagic effusion shows a large proportion of large endothelial cells, isolated or in groups, which are to be found as long as the effusion lasts (Widal, Ravaut and Lemierre). Vincent found lymphocytosis in a hæmorrhagic pleurisy due to typhoid bacilli. In Rosenthal's case the initial lymphocytosis gave way to polymorphonucleosis. In Macaigne and Théry's case pus containing typhoid bacilli showed a very high polymorphonucleosis with the cells considerably damaged, without eosinophils and with only a few mononuclears.

These effusions, whether serous, sero-purulent or hæmorrhagic, do not present, as a rule, any gravity. Usually they are absorbed spontaneously, without puncture and without leaving any trace. It is not the same with purulent effusions, which may end in empyema, an interlobar pleural abscess, or a vomica.

Circulatory System

Pericarditis and *endocarditis* are fairly rare in typhoid fever. Ulcerative endocarditis with the typhoid bacillus both in cultures and in sections, has been recorded (H. Vincent).

Myocarditis is extremely common in the course of the third week. It is very important to look for it. It is observed especially in the graver and prolonged forms, or in the ataxo-adynamic forms with hyperpyrexia. Myocarditis is revealed at its onset by acceleration and enfeeblement of the heart-beat, by muffling of the heart sounds, especially of the first sound, fall in the blood-pressure and failure and irregularity of the pulse.

But these phenomena are soon replaced by the fœtal or tic-tac rhythm to which Huchard has given the name of embryocardia.

In this case the two silent intervals become of equal duration, and the two sounds have the same intensity and the same tone. There is at the same time tachycardia. The pulse becomes frequent, small and compressible, then unequal, irregular, intermittent, and sometimes alternating : *i. e.* at regular intervals a strong and normal pulsation succeeds one which is small and inadequate. At this stage the patient's urine is scanty and albuminous ; pulmonary congestion may be noted.

In a more advanced stage the cardiac impulse is replaced by an indefinite undulation (Hayem).

On auscultation there is considerable weakening of the first sound, which may disappear completely. The second sound is not modified in the majority of cases, but it may, however, be reduplicated and get weaker until it disappears (Hayem). One may hear a very soft murmur, meso-systolic or even systolic in time, situated at the apex and conducted to the base.

The patient complains of intense dyspnœa and has a distressing air hunger. His face is cyanosed and his eyes wander. His temples are covered by a cold, clammy sweat. The lower limbs become œdematous. The pulse becomes feeble and cannot be counted.

Soon an algid collapse develops, which may be transient, last a few hours and disappear, or be the cause of death, simply from cardiac insufficiency, without asystole.

On other occasions the patient dies suddenly on making a simple movement or slight effort, or in a syncopal attack, without a cry or complaint of any kind. A syncopal attack is not necessarily fatal, but in cases which survive it aggravates the prognosis ; the patient will often develop chronic myocarditis, which sooner or later will lead to asystole.

It is necessary, therefore, to make a systematic examination daily for myocarditis. Knowledge of this frequent complication is of the utmost importance to the practitioner.

Veins—Typhoid Phlebitis. Thrombo-Phlebitis. Phlegmasia alba dolens

The type of typhoid phlebitis is the phlebitis of the veins of the lower limb, or *phlegmasia alba dolens*. Due, as a rule, not to the typhoid bacillus, but to the staphylococcus, the thrombosis affects principally the femoral vein, less frequently the saphenous and popliteal. It is more often unilateral than bilateral, and is almost always situated on the left. Trousseau thought it was rare, Murchison found it in 1 per cent., Hutinel in 6 per cent., Vincent in 8·23 per cent. among 340 cases of typhoid fever, and Da Costa in 12 per cent. Conner says, "If we can succeed in recognising the attenuated forms, it will probably be found in 10–15 per cent."

Phlebitis is a complication of convalescence, almost always occurring in the week or fortnight following the disappearance of the fever.

The onset is sometimes gradual, sometimes sudden with sharp pain and pronounced rise of temperature. The signs are those typical of phlebitis, with this difference, that the hard œdema is not white but is accompanied by a slight redness. Recovery takes place as a rule, but any of the complications may develop which have been noted as the sequel of any venous thrombosis, such as varicose veins, œdema, gangrene, pulmonary, cardiac or renal embolism, and sudden death.

Conner thinks that the typical symptoms do not appear till late, when the venous obliteration is an accomplished fact. He also regards the pleuro-pulmonary complications of typhoid fever as embolic in origin. The emboli are derived from friable thrombi, recently formed in veins which have not yet been obliterated, which would explain why their manifestations appear before the typical signs of phlebitis. The typical symptoms of these embolisms are—

1. An almost constant pain in the thorax, almost

invariably at the onset, appearing suddenly, and situated in the lower part of one of the axillæ.

2. Constant cough, with occasionally blood-stained expectoration (45 per cent.).

3. Oppression, dyspnœa, shivering and signs of pleurisy, with or without effusion, may be noted.

4. Finally, Conner insists on the value of a sign which he has found in all cases of confirmed or latent phlebitis, viz. *pain in the toes*, resulting from "an irritation of the plantar nerves due to a periphlebitic inflammation in the neighbourhood of the thrombosed veins in the region of the heel."

Perhaps a more simple explanation would be peripheral neuritis.

Arteries. Typhoid Arteritis.—Typhoid fever occupies the first rank among the infections which are the cause of arteritis. Like phlebitis, this arteritis is usually found in the lower limbs, but, unlike phlebitis, chiefly on the right side. The posterior tibial is the artery most frequently affected, and then the femoral, popliteal, anterior tibial and dorsalis pedis. Then come the arteries of the upper limbs, the iliacs, external carotid, Sylvian, etc. Arteritis of the limbs hardly ever occurs before the end of the third week, from the thirteenth to forty-first day (Rendu), or even up to the fifty-eighth (Barié), whereas arteritis of the visceral arterioles, which is much more frequent, is generally observed during the height of the disease.

The typical arteritis of typhoid fever—viz. that in the lower limb—begins with a pain which is more or less acute and sudden, but is always situated in the course of the arteries. Sometimes it is localised in the calf, the popliteal space, or Scarpa's triangle, but it may occupy the whole limb. It is greatly aggravated by walking, compression, standing, or the least movement.

The amplitude of the pulsation in the affected arteries is very much diminished, sometimes even the pulsation is entirely suppressed. The lower limb affected is first of all swollen, but without œdema or redness. Then it becomes mottled with violet patches, areas of

cyanosis, and even purpuric spots. The patient suffers from formication and other uneasy sensations in the leg, which grows cold.

The artery appears in the form of a hard and painful cord. Finally, dry gangrene, which terminates the process, involves elimination of the mortified tissues and death. In rare cases venous thrombosis may be observed at the same time as the obliterative arteritis (Patry).

Cases are on record of *parietal arteritis*, i.e. partial arterial obstruction, or narrowing of greater or less extent of the lumen of the vessel, in which the previous symptoms are attenuated and the lesions curable. When the arteritis affects other vessels than those of the lower limb, the gravity of the terminal gangrene is due to the functional importance of the organ supplied by the affected artery.

Blood.—During the febrile period a reduction of 70–80 per cent. in the amount of *hæmoglobin* may occur, and in grave cases it may fall even below 70 per cent. The number of red blood cells is slightly diminished during the first two weeks; a slight increase in their number, however, has been recorded. On the average the red cells number from 4,000,000 to 5,000,000 during the febrile period. At the time of defervescence there is a sudden diminution of the red cells. In severe forms this may be considerable: 804,000 red cells per cubic millimetre (Henry).

The *changes in the corpuscles* are of the ordinary kind: microcytes, megalocytes and polychromasia. After hæmorrhage some nucleated red cells have been seen.

The *colour index* is almost normal. Hénocque and Baudouin have seen the *activity of reduction for oxy-hæmoglobin* fall spectroscopically to 0·20 during the height of the disease, rising to 0·50 in convalescence and to 0·70–0·80 on recovery. Pignatti and Morano have seen an *increase in the mean resistance* of the red cells at the height of the disease, with a more or less sudden return to normal, and sometimes even diminution, in convalescence.

The *absorptive power* of the blood for oxygen is diminished (192–196 cc. of oxygen for 1000 grm. of blood instead of 240 cc.). The *leucocytes* have formed the object of numerous researches. It is well known that in normal conditions very slight causes are sufficient to cause variations, not only in the total number of leucocytes, but also in the differential count. It is therefore not surprising that the results published do not admit of comparison owing to the extreme variety of the cases, complications and incidents of all kinds, as well as the treatment, which may modify the result of the examinations.

Apart from differences of detail, it may be affirmed that typhoid fever does not increase the number of leucocytes. It may even cause a *leucopenia*, which disappears rapidly or slowly, once and for all, or on several occasions, either at the time of convalescence or a little before.

In the course of the first week the differential count shows an excess of polymorphonuclears, in the second and third weeks there are lymphocytosis and mononucleosis, with disappearance of the eosinophils. At the same time there appears in half the cases an iodophil reaction in the leucocytes, but we believe that its appearance coincides with the onset of complications, especially of an inflammatory nature.

From the prognostic standpoint the examination of the blood may furnish the following valuable information—

1. The reappearance of the eosinophils indicates the onset of convalescence within two or three days.

2. A rapid increase in the number of leucocytes may indicate a complication. This complication is of an inflammatory nature when the increase in the number of the leucocytes is accompanied by polymorphonucleosis, with an iodophil reaction.

3. A rapid and very pronounced decrease in the number of leucocytes indicates an aggravation of the disease, especially if it is accompanied by a diminution in the number of lymphocytes.

The blood platelets diminish in number until only 50 per 100,000 are found at the time of defervescence. Then they slowly increase, following an ascending curve, which attains its maximum twelve days after the end of defervescence (Hayem).

The *alkalinity* of the blood rises at the onset of typhoid fever, and then undergoes a progressive diminution.

The *coagulation time* does not show any remarkable modifications; it is, perhaps, a little delayed.

The *clot* is soft, forms slowly, sometimes even incompletely. The *amoumt of fibrin* varies from 1 gm. to 3·7 gm. per 1000, and sinks in proportion to the gravity of the disease.

Some importance has been attributed to the investigation of the fibrin network, between the slide and coverslip, according to Hayem's method. The absence of the fibrin network, or the slenderness of the fibrin threads, is not peculiar to typhoid fever; they are met with in a number of other febrile conditions, and especially in the eruptive fevers and acute miliary tuberculosis.

The *serum* which exudes from the clot varies considerably: it is abundant, clear and lemon-yellow when the clot is well formed, and its retraction is normal; it is somewhat scanty, and of a reddish colour when the clot is soft, retracts slowly and more or less completely. It may be lactescent.

The important characteristic of the blood serum in typhoid is the property which it possesses of agglutinating the specific bacillus from the moment of invasion. It is upon this idea, which is due to Widal, that the "serum diagnosis" of typhoid fever is founded.

Reserving for our special chapter on the laboratory diagnosis of typhoid fever a description of the technique of the serum test and the conclusions to be drawn therefrom, we will confine ourselves here to a consideration of the clinical significance of agglutination. Let us state first of all in what it consists. The phenomenon may be seen both microscopically and macroscopically.

If to 100 drops of a young culture (24 hours) of the typhoid bacillus be added a drop of typhoid serum, in a few minutes the microscope will show that the bacilli have lost their motility and are grouped in more or less considerable masses, between which may be seen a few isolated, but motionless, bacilli. If the mixture has been made in a small tube and put in the incubator, the fluid, which was turbid at first, becomes clear, and whitish flakes become deposited at the bottom of the tube. This agglutination reaction is specific; that is to say, peculiar to the typhoid bacillus.

Nevertheless, the serum of patients suffering from paratyphoid A can agglutinate indifferently the typhoid bacillus and the paratyphoid B bacillus (Sacquépée).

The serum of patients suffering from paratyphoid fever contains, in fact, fairly often coagglutinins and *cosensibilisatrices* (Rieux and Sacquépée).

This is the reason why exact information can be furnished by a blood-culture only. In the absence of a blood-culture, in non-vaccinated subjects the agglutination test should be used for the diagnosis of typhoid fever.

Normally the human blood serum does not contain an agglutinating power higher than 1 : 10 or 1 : 20. This power appears after anti-typhoid vaccination (1 : 50 to 1 : 10,000).

In pathological conditions it often appears in the course of the proteiform manifestations produced by the typhoid bacillus : such as typhoid fever, typhoid icterus, meningo-typhoid, etc. Generally speaking, the reaction in typhoid fever usually appears towards the seventh day. Widal has sometimes observed it on the third day. In the course of the disease the curve of agglutinating power is infinitely variable and unforeseen (Rouget). It persists for a varying period, such as a few months, or, more rarely, three years, six years, or as much as twenty-six years after the disease, and sometimes with remarkable intensity (1 : 8000 in a patient described by Widal and Sicard, who had recovered from typhoid eight years previously). Its appearance may be delayed till the second or third

week; it may appear only in convalescence or in the course of a relapse (Thoinot and Cavasse). Lastly, it may be absent altogether.

The serum may retain its agglutinating properties for three or four months after desiccation. This fact is important to know in view of a retrospective diagnosis or of a medico-legal report. The agglutinating reaction may pass from the mother to the fœtus (Widal and Sicard), but this passage is inconstant and incomplete.

Experimentally, the *sensibilisatrice* may be found in a young rabbit born of an infected mother (Vincent and Marbais).

The great variability in the appearance of the agglutinating reaction, in spite of its specific value, has induced the clinician to seek in the blood for the actual cause of the reaction which indicates the infection. This investigation is carried out by a *blood-culture*, with which we shall deal later.

It has been found that the blood plasma, fluid from blisters, nurse's milk, tears, aqueous humour, bile, fluid from œdema and inflammatory serum may possess specific agglutinating properties of varying intensity in the course of a typhoid infection.

The *toxicity* of blood serum may be considerable in the course of the second week of typhoid fever, whereas it is normal in the first and third weeks.

The *hæmolytic power* of the blood is increased in typhoid fever. The *attenuation of certain blood ferments* is a very grave symptom, and as a rule the herald of a rapid termination (Achard and Clerc).

The Pulse and Temperature

The study of the changes in the pulse and the temperature curve are not only valuable elements in diagnosis, but when the diagnosis is established it is by them chiefly that the medical man can judge of the course of the disease, appreciate the patient's resistance, establish an immediate or remote prognosis and decide to intervene or abstain from treatment. The

pulse and temperature should be so frequently compared with each other that, contrary to the plan adopted in this work, it appeared to us to be of real practical interest to study them here side by side. It may also be well to recall the normal and physiological characters of the pulse and temperature, so as to illustrate their variations in the course of typhoid fever.

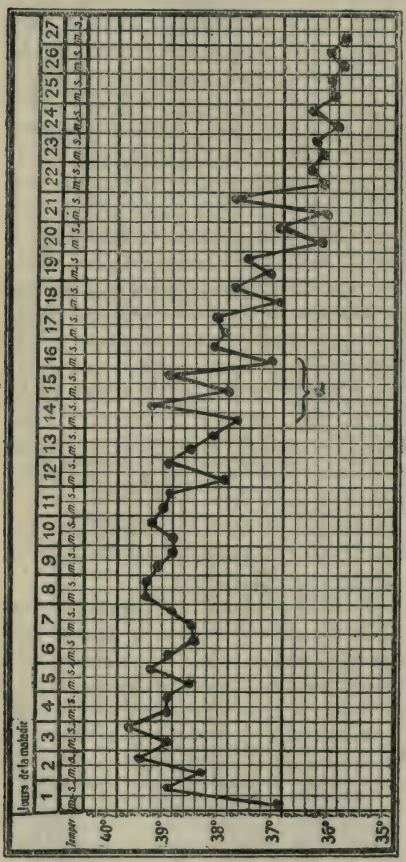


FIG. 3.—Typhoid fever. Temperature taken from the first day. Sudden onset. *a*. amphibolic stage.

Pulse. — Normally, the rate of the pulse is, on the average, 120 per minute in an infant a year old, 100 in a child of three years, 80 in a child of 8–10 years, and 70 in an adult.

It becomes more rapid in the first weeks of typhoid fever; it remains rapid at the height of the disease, and loses its frequency in defervescence.

The acceleration, which is more pronounced in

women and children than in the adult, varies considerably.

" Out of 100 cases, I ascertained that it exceeded the normal standard, at some time of the fever, in all but 1; in 97 cases it exceeded 90; in 85 cases it exceeded 100; in 70 cases it exceeded 110; in 32 cases it exceeded 120; in 25 cases it exceeded 130; in 10 cases it was above 140; and in 2, above 150 " (Murchison).

The frequency of the pulse undergoes great variations from one day to another, and even at different hours of the same day. In the evening there may be 10–30 beats more than in the morning.

The pulse is accelerated by a pulmonary complication or an intestinal hæmorrhage.

As a general rule, the severest cases are those in which the pulse is most rapid, and usually it is a bad prognosis when the pulse in the adult keeps above 120–130 (Fig. 1). In some cases the pulse may be very slow (as low as 37 beats per minute), or never vary from the normal.

Irregularities of the pulse (arrhythmia, intermittence) are not rare.

Characters of the arterial wave. Dicrotism.—At the onset of the disease, during the first eight or ten days, the pulse is strong, full and of good tension, but soon it becomes soft and compressible. At a more advanced period it may be small, feeble, undulating, irregular, intermittent or imperceptible.

One of the most remarkable characters of the typhoid pulse at the height of the disease is *dicrotism.* It is well known that on sphygmographic tracings the cardiac systole corresponds not only to the line of ascent but also to the line of descent. The arterial pressure, in fact, increases until the moment when the heart suspends its systolic effort, and the pressure falls only at the moment when the sigmoid valves of the aorta close. The impact of the column of blood on the valves is indicated on the descending line of the tracing by an undulation which is called " the rebound of the pulse," or " dicrotism." Dicrotism, therefore, is a normal element of the pulse, too weak to be felt by the finger, but

strong enough to be registered on the sphygmographic tracing. In typhoid fever this dicrotism becomes exaggerated until it becomes perceptible to the finger. It increases in proportion to the weakness of the arterial pressure and the rapidity of the heart-beat. Cold baths may cause it to disappear; its return may indicate a threatening hæmorrhage (Paviot).

The arterial pressure is very low in the typhoid patient (Potain), but this fall is only of secondary importance, the changes in the arterial pressure being related to the frequency of the pulse (Azelais).

Temperature.—It is well known that in the healthy man the rectal temperature varies at different hours of the day. On waking up at six o'clock in the morning it is, on the average, 98·4° F. It rises progressively to a maximum which varies from 99·0° to 99·5° at about seven p.m., and then sinks to a minimum of about 98·0° F. towards three or four a.m., to rise later. We may say here that, normally, the excursions of the temperature are, on the average, a degree and a half.

The same daily variations occur in typhoid fever, but the excursions are more marked.

In this disease the morning temperature oscillates generally between 103·2° and 104° F., and the evening temperature between 104° and 105·2° F. The fluctuation is from 0·8° to 2° F. But these oscillations may be greater, and at the height of the disease be as much as 3·6° F. Lastly, in some cases the temperature tends to return to the normal level; it rises again in the evening, and the great oscillations which result therefrom constitute the *amphibolic* stage of Jaccoud.

Charts may also be seen in which the maximum temperatures occur in the morning and the minimum in the evening. These *inverse types* never appear throughout the extent of the febrile cycle.

Their significance is not known apart from the cases in which the patient is suffering simultaneously from malaria or tuberculosis, or has been treated by antipyretic drugs.

But the clinical importance of the cyclical course of

temperature is even greater than its daily variations. Typhoid fever may be classed among those diseases in which the temperature curve usually pursues the same, or almost the same, course. There is, however, nothing absolute about it, for a slight complication is enough to modify the temperature curve and disguise it effectually.

Ordinary Course of the Temperature in Normal Typhoid Fever.—In the *incubation period*, in quite exceptional cases, a slight pre-febrile temperature may be noted, usually in the evening, sometimes also in the morning, reaching 99·6° or 100,° but never exceeding 100·4° F. (Vaucher and Dufour, Roch).

Starting with the truly clinical period of typhoid fever, the temperature curve may be schematically compared, according to Jaccoud, to the three upper sides of a trapezium. The oblique ascending line corresponds to the period of onset, or *ascending oscillations;* the horizontal line corresponds to the height of the disease, or *stationary oscillations;* and the oblique descending line indicates the period of decline, or *descending oscillations.*

At the period of onset (Fig. 4) the temperature rises progressively and slowly, exceeding each evening, by a degree or more, the corresponding temperature of the evening before, with a morning remission which also keeps above the record of the previous morning by one or more degrees.

These ascending oscillations are rarely seen in the army, as the patients come to the doctor too late.

In about four days of this staircase-like ascent the temperature is about 103° F. It keeps at this level during the two weeks which constitute the ordinary duration of the height of the disease. During this period the morning remission varies from 1° to 1·8° F. at most. The temperature curve may then be compared to the serrations of a saw, the base of each serration being 102·2° and the point about 103·0.°

However, at the onset of this period of stationary oscillations, and especially about the sixth or seventh

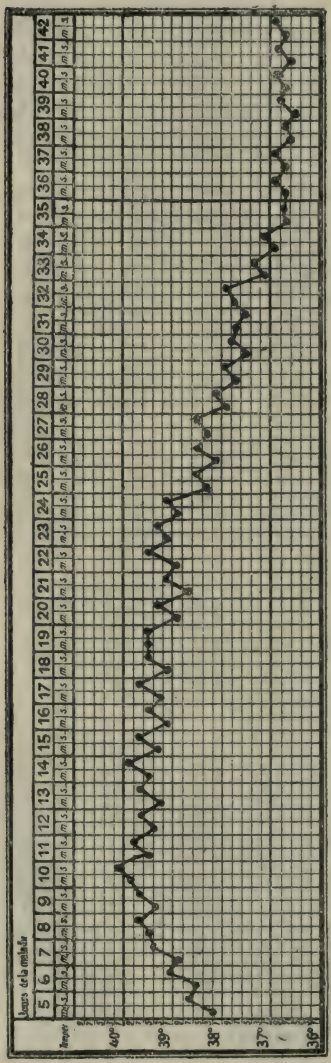


FIG. 4.—M. L. aged 22 years. Late and sudden death from myocarditis on 56th day.

day, a fall of temperature nearly to normal is very often seen, constituting a sort of sudden and temporary remission, varying from 1·8° to 4·4°, and only lasting from ten to twelve hours on the average. It is probably a sort of *thermic crisis* which indicates a defensive state of the organism, for at this moment the existence of antibodies in the blood may be first noticed.

During the height of the disease the temperature shows a certain stability. The fastigium of typhoid fever has been called by the name of *plateau*. During this period the evening rise ranges between 104·2° and 104·8°, the morning temperatures being, on the average, 0·8° to 2·6° lower. The height of the disease, in the majority of cases, presents a single plateau, but this plateau may be divided into two, each lasting a week, the second being a little above or below

the first. In severe cases the temperature curve is irregular, capricious and steep, with temporary rises and falls of grave prognosis.

It is especially in warm countries that such cases are seen. Sometimes the fastigium is prolonged to the third or fourth week.

It is at this period that the *amphibolic stage* of Jaccoud must be placed (Fig. 3). It is formed by oscillations of great amplitude succeeding one another without any order for three or four days, and giving the curve a hesitating and uncertain character, and followed by frankly febrile temperature and actual hypothermia. If the termination is to be fatal, the temperature rises to 107·6° and even higher (109·4°), or, more rarely, it falls considerably until death, which takes place from collapse.

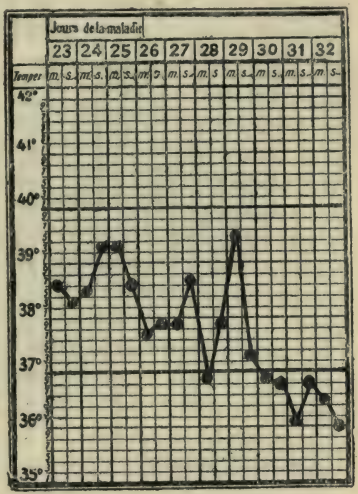


Fig. 5.—Meningeal symptoms (delirium, coma, strabismus, etc.) towards the end of typhoid fever on 27th day. Sudden defervescence.

In favourable cases, whatever may have been the duration and form of the fastigium, *defervescence* occurs in one of two manners: slowly and gradually by lysis, or suddenly. Sometimes, though rarely, a crisis is seen, characterised by very unusual nervous symptoms resembling those of meningitis (Fig. 5). In defervescence by lysis the curve is exactly the reverse of that of the ascending oscillations. The descent is made by steps constituting a sort of "exit staircase" for typhoid fever. In cases of sudden

defervescence this stage of descending oscillations may be entirely suppressed (Fig. 5). Very frequently, after an apyrexial period of a few days, a slight hypothermia (98·0°–98·2°) may be found, which is more pronounced in the old and debilitated, and after long and severe fevers, and may sink to 96·8° and even 95·8.° In a few days the temperature becomes normal again.

Such is the typical chart of the temperature in normal typhoid fever, which is fairly often realised. It may undergo numerous variations. The onset is not always progressive : it may be "brutal," the disease may "explode" (Guéneau de Mussy), and the temperature may in this case jump from 98·6° to 104°, imitating the onset of pneumonia.

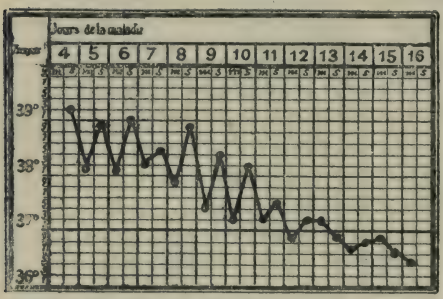


FIG. 6.—Hospital orderly. Mild typhoid fever. Defervescence by lysis.

It is well known that paratyphoid fevers frequently have a sudden onset.

In certain grave forms (ataxic and ataxo-adynamic) the temperature curve is extremely irregular. The temperature of the plateau is 104° and above.

Contrasting with these hypothermic forms are others in which the temperature is but little raised, and in which the plateau oscillates between 100·4° and 101·2°. There are also absolutely apyretic forms of typhoid fever in which the temperature is 98·6° or 99·4° throughout the whole course of the disease (H. Vincent). Lastly, Potain has recorded a case of hypothermic typhoid in which the temperature fell from 98·6° to 97·2°, where it remained until convalescence, when it rose again to 98·6°.

Certain events contribute to modify profoundly the

regularity of the temperature curve, some causing a rise and others a fall.

Complications which raise the temperature are numerous. At the onset these are the secondary infections of the pharynx, and a superadded disease (influenza, diphtheria, erysipelas, etc.).

At the height of the disease they are the pulmonary complications (bronchitis, broncho-pneumonia) bedsores, suppuration of the skin, otitis, parotitis, abscesses, phlebitis, peritonitis by propagation, etc. In convalescence they are errors in diet, fatigue, lesions of the bones or periosteum, constipation, return of the menstrual period in women (the last may give rise to false symptoms of peritonitis), etc.

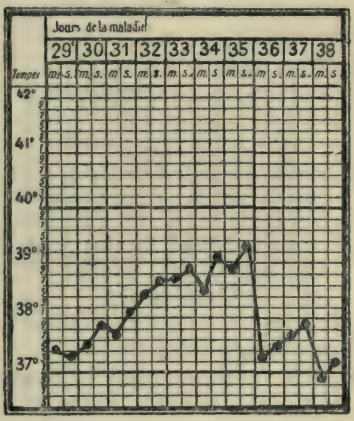


FIG. 7.—Man, aged 59. Typhoid fever in course of recovery. Formation of a renal abscess (staphylococci and typhoid bacilli). Spontaneous opening of the abscess on 36th day.

Among the complications which may cause a fall of temperature, the most important are hæmorrhages (intestinal hæmorrhage, profuse or repeated epistaxis, delivery or abortion), perforation, myocarditis, profuse diarrhœa, extensive bedsores, etc.

Relations between the Temperature and the Pulse.—As a general rule, in febrile conditions if the temperature rises a degree (1·8° F.), the pulse increases by about fifteen beats.

In typhoid fever a high temperature has corresponding to it a pulse which relatively is but little accelerated. A change in this formula in the sense of acceleration of the pulse is a grave sign. Thus a temperature of 105·8° is not a bad sign if the pulse is not accelerated. On the

other hand, the prognosis is gloomy if the pulse and temperature rise simultaneously.

A low temperature and a rapid pulse should be regarded as a grave case. If the temperature falls and the pulse becomes rapid, one should think of the possibility of intestinal perforation or hæmorrhage.

Lastly, if in the course of a regular defervescence by lysis an increase in the number of pulse-beats is found, the possibility of a cardiac complication should be considered.

Nervous System

Typhoid fever, like all infectious diseases, is liable to affect the nervous system.

The central anatomical lesions which cause these symptoms, and are due to the toxins (exo- and endotoxins) secreted by the typhoid bacillus, are still entirely unknown to us. Direct injection of the typhoid toxin into the brain of a dog causes complete necrosis of the nervous tissue. But that is a case of a gross and experimental lesion.

The nervous symptoms appear at a variable period of typhoid fever. They disappear, become attenuated or persist after recovery. Sometimes the nervous manifestations dominate the clinical picture, thus justifying the creation of special forms such as the ataxic, ataxo-adynamic, delirious, comatose, etc.

In predisposed subjects the infection provokes the appearance, aggravation or return of latent nervous defects, which have been attenuated or apparently cured. Lastly, it acts as a provocative agent in certain neuropathies.

All these manifestations we must now consider in detail.

Nervous Symptoms.—These may be classified as follows—

1. Symptoms of an ordinary kind if considered individually, but as the result of their special grouping

in typhoid fever, forming a peculiar syndrome which has been given the name of "*typhoid state.*"

2. Psychical disturbances.
3. Sensory troubles.
4. Motor troubles.
5. Meningeal syndromes (meningitis and meningism or meningeal states).
6. Troubles of the organs of special sense.

1. **Typhoid State.**—The nervous symptoms of the typhoid state are *prostration, stupor, insomnia, somnolence, tremors or muscular twitchings,* and *carphology.*

Prostration, Stupor, Insomnia, Somnolence.—Prostration exists in every case, but in variable degrees. Sometimes the patient really seems like an inert body (Louis), unable to move in bed or attend to his needs. Other patients, on the contrary, can sit up in bed, get up to go to the closet, and even attend hospital for advice.

Prostration is sometimes a symptom of the onset, especially in warm countries, or in soldiers in war time. As a rule it appears late in the course of the second week, becoming pronounced towards the end of that week or towards the middle of the third week.

Sphincter troubles are closely associated with prostration. The stools and urine escape involuntarily; retention of urine, necessitating employment of the catheter, is much rarer. During the first eight or ten days of the disease the patient cannot sleep, or his sleep is much disturbed by dreams and nightmares.

Somnolence immediately follows insomnia, at the beginning of the second week, but it may be observed from the onset. It may be slight, moderate or deep. Sometimes the patient wanders at night, while in the daytime he remains dull and drowsy, with his eyes half closed and a vacant look; he remains in a somnolent state, with intervals of delirium. The graver the case, the earlier, the more intense and the more prolonged is the somnolence (Louis).

The typhoid patient may often have what has been

called the "typhoid facies;" the face is pale, with a circumscribed flush on one or both cheeks, the expression is one of prostration and stupor, the pupils are dilated, and the eyes sunken. He is incapable of any rational act, and indifferent to persons and things, but in a varying degree. He has difficulty in putting out his tongue, but once protruded he leaves it in its new position.

Tremors and muscular twitchings.—Murchison noted tremor of the hands, tongue and lips in twenty-seven out of a hundred cases. He also found subsultus, contractions of the mouth and hiccough in some cases. Children may have choreic movements.

In the course of the present war R. Mercier and R. Meunier found in 68 per cent. of the cases (175 soldiers) continuous tremors, with periodic exacerbations characterised by rapid oscillations (8 per second) of moderate amplitude, with a maximum amplitude in the acute stage. These tremors were independent of the will, and purely reflex, and were present at all periods of the disease. They were most pronounced in soldiers who had undergone much fatigue.

Carphology.—It is not uncommon to find automatic movements in typhoid fever. Children constantly put their hands to their nose and bite their lips till they bleed. Some patients push off their bedclothes and try to get up, or continually put their hands on their genitals. But the most frequent of these automatic movements is that known by the name of *Carphology*. The patient "moves his hands to and fro above his bed and seems to be groping for small objects hanging in the air, or to be constantly looking for them in his bedclothes, from which he pulls out the nap." This continues, without interruption, for hours. Cold-bath treatment has much reduced the frequency and gravity of the stupor and other nervous phenomena accompanying typhoid fever.

2. **Psychical Disturbances.**—*Delirium.*—Delirium is frequent in typhoid fever, especially in subjects who are nervous, depressed, overworked, alcoholic, or

in a state of exhaustion. At the onset the patient's sleep is broken and he suffers from nightmare. In the daytime he gives himself up to monotonous reverie. At the height of the disease the delirium is at first quiet, and presents the oneiric character peculiar to infective and toxic delirium (Régis). It is often nocturnal. The patient mutters incoherent words in a sort of dream, and in the morning ends by going to sleep.

The delirium afterwards becomes diurnal, and then both diurnal and nocturnal; the prognosis is now more serious, even if the delirium is a peaceful one. But in some cases it becomes violent. It is accompanied by cries and disorderly movements, and above all it becomes an active delirium; the patient gets out of bed, tries to escape and has to be restrained. According to Régis, these are examples of acute psychosis with terrifying hallucinations—ideas of persecution, religious mania and megalomaniac ideas.

Subjects without any predisposition show an active delirium with a melancholic state, or a profound stupor with considerable mental excitement. The psychosis of the predisposed is a real acute delirium of extreme gravity, with muscular agitation, inco-ordination, tonic or clonic convulsive attacks, and albuminuria, which may end in collapse. In short, it is some form of mental confusion, such as hallucinatory delirium, stupor or acute delirium.

Lastly, in the course of every war varieties of delirium have been observed which Devaux and Logre have called by the name of "war delirium." Their theme is essentially a military one, such as dreams and visions of fighting, conversations and discussions about strategy, grim and fantastical stories of massacres or deaths on the field of honour followed by resurrections, scenes of the trenches or the battlefield, cries, restlessness, the patient asking for his gun and wanting to fight; ideas of military glory, melancholy ideas of guilt, of sentence by a court-martial and execution; struggles with imaginary enemies,

Uhlans, spiked helmets, etc. These symptoms of mental confusion show how deeply the patients' minds have been impressed by the war, which, with its picturesque and dramatic features, forms almost the only object of their professional delirium.

In convalescence some patients continue to suffer from the same psychical disturbances as they had during the height of the disease. When they occur at this time, and are not due to the administration of caffeine, these disturbances are due to inanition, and disappear as soon as the ordinary diet is resumed.

Typhoid fever, however, may be followed by the appearance or return of transitory or permanent mental disorders, such as mania, or chronic insanity assuming the hypochondriac, religious, melancholic, erotic, or even ambitious form. Mental degeneration, various forms of insanity, and general paralysis also occur after typhoid fever. As a rule, the intellectual and affective faculties are weakened, and memory and attention are considerably impaired.

3. Sensory Troubles.—The disturbance of general sensibility shows no peculiar features; sometimes one finds cutaneous anæsthesia, and sometimes hyperæsthesia due to neuritis, especially in the lower limbs.

At the period of onset the patient has pains all over the body, down the spine, in the limbs, especially the legs, in the epigastrium, the nape of the neck, and the joints. At the height of the disease the pain disappears or improves.

There is, however, one symptom whose frequency, early appearance and duration entitles it to a special description: viz. headache.

Headache is one of the first and most constant symptoms. It is usually very intense during the first week, and the patient attributes his insomnia to this cause. It is usually frontal, but is sometimes occipital and may be generalised and accompanied by hyperæsthesia of the scalp. It is generally a dull and wearing pain, without any sharp or stabbing characters. In most cases the patient is unable to work or think;

noise, light and smell affect him most disagreeably, he feels giddy when he changes his position or sits up in bed.

In moderate cases the headache lasts throughout the disease, in severer cases it disappears as the patient sinks into a condition of stupor. Lastly, in some of the so-called ambulatory cases, headache is often the only symptom.

Giddiness disappears with the headache, but returns, with or without it, at the beginning of convalescence.

4. **Motor Troubles.**—Whereas the sensory disturbances at the period of onset are specially localised in the lower limbs and the spine, the motor disorders are localised in the upper limbs, trunk and neck. The patient has *spasms* and *convulsive movements*, such as trismus, strabismus, hiccough, etc. *Generalised convulsions* are rarer than in typhus and less frequently of a uræmic nature. Some patients have *epileptiform attacks*, in which they foam at the mouth and bite the tongue, the attacks being preceded by acute delirium and followed by profound prostration.

Aphasia has been observed in the adult, and more frequently in the child, during the course of the disease or in convalescence, but this symptom is of short duration and may last only twenty-four hours.

Acute polioencephalitis has been noted in subjects under two years of age. Its pathogeny is still obscure. The onset is sudden and characterised by convulsions, vomiting and fever. Then it is noticed that one half of the body has become paralysed. The paralysis is most marked in the arm; the face is rarely affected. The parts affected show maldevelopment, so that shortening of the arm, amounting to five or six cm., may result from the infection.

The *reflexes* are exaggerated; *contractures* are exceptional.

Sometimes the patient suffers from *partial epilepsy*, or, more frequently, *hemi-athetosis* with mental disturbance.

The typhoid toxin is liable to cause extensive lesions

in the cord. Typhoid myelitis may assume the type of *acute ascending paralysis*, or *Landry's disease*. In some cases the initial symptoms are attributed to influenza or gastric derangement. In others the myelitis is characterised by pains in the trunk and limbs, anorexia, shivering and, above all, by fever.

At the height of the disease enlargement of the spleen is a guide to diagnosis. Death is the ordinary termination of the disease.

Typhoid fever may be followed by all the known types of *paralysis*, as is the rule after all infections. But post-typhoid paralyses are characterised by the motor troubles being usually incomplete, and being accompanied by various sensory disturbances.

5. **Meningeal Syndromes.**—*Meningitis, Meningism or "Meningeal States."*—We will not deal here with the *primary meningitis*, which is one of the forms of typhoid septicæmia due to localisation of the specific bacillus in the meninges. Nothing differentiates it clinically from acute cerebro-spinal meningitis; diagnosis can be made only by examination of the cerebro-spinal fluid.

The most frequent meningeal symptoms in typhoid fever are those observed at the height of the disease, from the sixth to the twentieth day, and more rarely in convalescence or in the course of a relapse.

The onset may be sudden and violent, but is more often insidious. Sometimes all the symptoms of the *meningeal syndrome* are present, viz. *headache, photophobia, pain in the spine, vomiting, contractures, and gun-hammer position.*

In children the picture is frequently completed by convulsive attacks which may give rise to a special eclamptic form. But as a rule the picture is incomplete, only headache and rigidity being present, together with Kernig's sign, which is constantly found.

As isolated symptoms, bradycardia, tachycardia, hiccough, sudden amaurosis and ocular palsies have been noted. Sometimes there are severe forms of true typhoid meningitis (meningo-typhoid), with a

turbid or purulent cerebro-spinal fluid, containing the typhoid bacillus. Sometimes the fluid is clear. The disease should then be regarded as an example of the meningism of Dupré, and this meningeal state disappears spontaneously or after lumbar puncture. Or, again, when there is nothing to suggest the onset of typhoid fever, but there are merely vague symptoms of a general infection, or even no prodromes at all, undoubted signs of acute meningitis suddenly appear. The cerebro-spinal fluid is under hypertension, clear in colour, and does not contain the typhoid bacillus, which alone can furnish a diagnosis.

It is only the special course of the disease which indicates its typhoid origin. In a few days, when the meningeal symptoms have disappeared, the more typical symptoms of typhoid fever appear, viz. the typhoid facies, the caked tongue, lenticular rose spots, etc. In exceptional cases at the onset, in the course of the disease or in convalescence, one may find meningitis produced by the germs of secondary infection, either alone or in association with the typhoid bacillus, such as the staphylococcus (Sergent and Lemaire, Giraudet, Breton), the pneumococcus alone (Dervitte, Sacquépée), or associated with the typhoid bacillus (Vincent), the tubercle bacillus (Chantemesse and Ramond, Comby), and the streptococcus (Vaillard and Vincent). There is nothing to distinguish them from suppurative meningitis. They are always fatal.

Special Senses

Organ of vision.—The patients often complain of a sensation of dazzling; often they close their lids as if they had photophobia. Jenner and Gairdner have noted a dilatation of the pupils which contrasts with the contraction of the pupils seen in typhus. Contracted pupils may, however, be found in typhoid fever also.

Keratomalacia and necrosis of the cornea have been noted (Trousseau), and also phlebitis with

phlegmon of the eye and orbit, irido-choroiditis, chorio-retinitis, etc.

Organ of hearing.—Patients complain from the beginning of the disease of *buzzing* and ringing in the ears. They may present *hardness of hearing* and even *deafness*, which is usually bilateral, without lesions of the ear, which suggests a central origin. *Suppurative otitis media* is not uncommon, and may cause in severe cases absolute destruction of the tympanum and loss of the ossicles. Every degree of deafness may be observed after these attacks of otitis.

Liver and Gall Bladder

Modern researches have established experimentally the theory of *descending infection*, as opposed to the theory of *ascending infection*, to explain infective icterus.

The initial phenomenon is septicæmia, which is observed during the incubation period before the appearance of any obvious clinical sign. The intestinal lesion, which may be absent, should be merely regarded as one of the localisations of the typhoid bacillus, like the other lesions.

Experiments on animals and surgical operations on the human gall-bladder during life have shown the special localisation of the typhoid bacilli in the gall-bladder.

This localisation is usually accompanied by hepatitis and catarrhal angiocholecystitis, which at their onset have no clinical symptoms. In the course of typhoid fever one may observe suppurative cholecystitis, diffuse hepatitis and even hepatic abscesses containing the typhoid bacillus.

Some typhoid infections resemble relapsing jaundice. The infectious jaundice merely indicates the localisation in the liver.

Mild primary infective jaundice and catarrhal jaundice are the terms applied to different degrees of the typhoid infection. Chauffard, in particular, has contributed

to establishing this identity from a study of epidemics of jaundice contracted at the same source, and in which the jaundice may assume every clinical variety, including even icterus gravis. *Mild icterus*, which appears towards the third or fourth week, is of transient duration, and is accompanied by some tenderness and swelling of the liver, the stools retaining their colour.

Infective jaundice of moderate intensity is accompanied by more alarming symptoms.

" The onset is usually sudden; the patient is seized with shivering and fever, he complains of pains in the back and limbs, giddiness and headache, which is sometimes intense; digestive disturbance is constant, the tongue coated, anorexia absolute and vomiting frequent; there is a bilious diarrhœa which is usually profuse, and the temperature fluctuates between 100·4° and 104° F.

" The urine is scanty, dark and albuminous. The liver and spleen are often enlarged " (Gilbert and Fournier). The jaundice is intense, but the stools are not clay-coloured. In a few days improvement sets in and the jaundice gradually disappears.

Lastly, we may meet with grave *infective jaundice*, which ends in coma within a few days.

The typhoid state is intense, the jaundice is very marked at the onset and becomes progressively less. There are vomiting, erythemata, hæmorrhages, delirium, mental confusion, and high temperature with a more or less pronounced and persistent fall. " In these forms there is an association of the two anatomo-clinical syndromes, acute angiocholitis and hepatic insufficiency, but the two syndromes do not run parallel in their intensity " (Laignel-Lavastine).

Cholecystitis is not uncommon. It may be early (from the eighth to the eighteenth day) or late (from the twenty-ninth to the fifty-seventh day, or even longer still, after defervescence). In the first case it does not in any way affect the temperature curve; in the second case a slight and transient rise of temperature is sometimes noted.

Jaundice is exceptional. Pain is spontaneous or caused by pressure over the gall bladder, and is accompanied by muscular resistance localised in the right hypochondrium. To investigate this sign, which is present at the onset and at the height of the disease in every case of typhoid fever (Chauffard, Nobécourt, Paisseau and Marinier), the doctor should be on the right side of the patient's bed and pass his left hand backwards along the lower border of the ribs, so as to make the liver project forwards. The right hand should now depress the abdominal wall gently and progressively on to the gall bladder until the patient complains of a more or less sharp pain. This sign lasts until the beginning of convalescence. Its persistence after the temperature has fallen should make one fear a relapse (Radulesco and Atanassiu). In addition to this sign of tenderness of the gall bladder, we should note the *impaired resonance at the right base* which, according to Lesieur, is to be found by light percussion of the right base of the thorax. The upward enlargement of the liver is responsible for this impaired resonance. It is present in 80 to 90 per cent. of the cases and occurs earlier than the rose spots, serum reaction, enlargement of the spleen and diarrhœa. It diminishes and disappears in defervescence. Its return during convalescence indicates the onset of a relapse.

Hepatic abscesses in typhoid fever appear about the fourth or fifth week and are revealed by shivering, fever, grave general condition, meteorism and pain localised in the right hypochondrium in the region of the last costal cartilages. The liver is large and painful. The disease may run an acute, sub-acute or chronic course, and terminates fatally when the abscesses are multiple, or by opening into the intestine, peritoneum or lung when the abscess is big.

Peritoneum

Peritonitis in typhoid fever may originate from lesions of the spleen, liver and gall-gladder, etc.,

but the most frequent cause is perforation of the intestine.

We have already studied intestinal perforation and the peritonitis which results therefrom. Although it has been disputed by Dieulafoy, there is no doubt that inflammation may be propagated by continuity from the mucous to the peritoneal coat of the bowel without any perforation (Trousseau). In such cases the starting-point of peritonitis by propagation is to be found in a whitish, more or less adherent exudation on the non-ulcerated peritoneal surface, corresponding to a Peyer's patch.

This form of peritonitis has no special clinical symptoms.

Urinary System

Kidney.—Nephritis is fairly frequent in typhoid fever. Murchison says that he found it in 25 per cent. of his cases; Griesinger noted it in a third of his cases; Gubler and A. Robin state that it is *always* present. As a rule, the only symptom is the presence of *albumin* in the urine (at least, in the mild or moderate cases), apart from complications. It appears at dates varying from the first week to the middle of the third. The date of onset, amount and duration appear to be related to the severity of the disease. As a rule, it disappears in defervescence, but may persist and be the sign of a chronic renal lesion.

Robin has described a "renal form of typhoid fever" with the following clinical signs: slight diarrhœa, great prostration, adynamia, earthy pallor of the skin, lumbar pain, dyspnœa, profuse epistaxis, early cerebral phenomena, very high temperature, with great liability to chill, and extreme gravity. There is also a primary acute hæmorrhagic nephritis due to the typhoid bacillus, and some forms of acute non-hæmorrhagic nephritis may be due to the same cause.

Typhoid nephritis is very rarely associated with œdema and anasarca.

Convulsions of uræmic origin are also rare.

Bladder.—Relaxation of the sphincters with *involuntary emission of urine, and retention* necessitating the use of a catheter, have been noted.

Cases of cystitis manifested by pyuria in which the typhoid bacillus was present have been reported (Vincent, Lévi and Lemierre). A less frequent occurrence is a vesical syndrome of mild degree, characterised by frequent and painful micturition, a feeling of weight in the bladder, tenesmus and slight hæmaturia. These symptoms may disappear in a few days, but the pyuria may persist, and bacteriuria may outlast pyuria.

The urine in typhoid fever.—The quantity of urine passed by the typhoid patient (1) diminishes during the height of the disease; (2) increases slowly and progressively during defervescence; (3) is abundant at the onset of convalescence. This polyuria has received the name of "urinary crisis."

The physical characters, density and reaction of the urine vary with the quantity passed. At the height of the disease it is the colour of beef-tea with green, red or brown reflections (Gubler and Robin). Its specific gravity is 1015–1030 and more. It is extremely acid. On defervescence the specific gravity falls to 1017–1019, and even to 1005–1003 at the time of the urinary crisis.

The urine becomes paler and clearer as it gets more abundant. Its acidity may diminish until it becomes alkaline.

Urea increases during the first week (28, 57, 62, 78 grammes according to certain authors); it diminishes during the height of the disease, but remains above normal and becomes subnormal in convalescence.

Uric acid increases in the febrile period. From the normal 0·40 it may increase to 7·30 grammes on the seventeenth day (H. Jones).

It then decreases and falls below normal in convalescence. The *chlorides* passed in the urine may be reduced to a mere trace (Murchison).

Laubry thinks that there are periods of retention,

alternating with small discharges, which precede the abundant discharge of chlorides in convalescence. According to this writer, the chloride crisis at the end of typhoid fever may occur in one of three ways—

1. A sudden and complete discharge (20 grammes per day for several days).

2. An isolated and ephemeral discharge, followed by a very short retention or by a slow and progressive return of the chlorides to normal.

3. A slow and continuous discharge, which sometimes does not occur till ordinary diet is resumed.

The *phosphates* and *sulphates* may be slightly diminished.

There is no infection with intestinal lesions in which so much urinary *indican* is found as typhoid fever. *Leucin* and *tyrosin* are most likely to be found in severe cases. *Creatinin* is never absent.

The *urinary toxicity* is increased (Roques and Weil). From the prognostic point of view the chloride crisis alone appears to be of significance; a sudden discharge indicates a convalescence with normal evolution, while a slow discharge may indicate a relapse.

Diazo-Reaction

The diazo-reaction, as a colour test for the urine, has long been regarded as specific for typhoid fever.

Further investigations by several authors have shown that it is present in several febrile diseases, *e. g.* measles, pneumonia, scarlet fever and erysipelas. In typhoid fever it appears from the second to the sixth day, and lasts till the fifteenth to the twentieth day, according to the case, gradually losing its intensity.

It reappears with fresh rises of temperature, and up to a certain point its intensity is parallel with the fever.

The reaction has undergone certain modifications. The following method is much more delicate than the original one and often gives immediate results.

Reagents.

1. Paramidoacetophenol 0 gramme 50
   Concentrated HCl 50 grammes
   Dissolve and add
   Aq. destill q.s. 1000 c.m³
2. Sodium Nitrite 0 gramme 50
   Distilled water 1000 c.m.³

The urine to be examined should have been passed very recently, for the reaction disappears in a few hours after micturition.

Pour 10 c.c. of solution (1) into a long test tube and mix with four drops of the nitrite solution (2), and then add 10 c.c. of urine. Shake, make alkaline with 3 c.c. of ammonia and shake again vigorously. A positive reaction is shown by the scarlet red colour of the *froth.*

The Moriz-Weiss reaction with permanganate of potash has even less value than the diazo-reaction.

Various Glands and Systems

Salivary glands.—The salivary secretion is usually diminished, sometimes even almost completely suppressed. A few cases, however, of veritable sialorrhœa are on record (Merklen and Milhit).

Parotitis may be a sequela of adynamic and prolonged attacks. It is usually suppurative, and complicated with sloughing and extensive sinuses. The prognosis is grave.

The *pancreas* and *thyroid gland* may be the seat of more or less severe inflammatory lesions.

Testicle.—Patients aged from sixteen to thirty, in convalescence from an attack of moderate severity, may suddenly develop orchitis, either alone or in association with epididymitis, or epididymitis alone.

The symptoms are those of the orchitis of mumps, an effusion into the tunica vaginalis being exceptional.

The complication lasts about twelve days on the

average (Ollivier), but may be much longer. Suppuration may occur.

The typhoid bacillus has been isolated in these cases (Vincent).

Female genital organs.—Inflammatory swelling of the labia majora, ending in suppuration, vulvitis, Bartholinitis, retro- or peri-uterine hæmatocele, and a more or less severe gangrene of the vulva have been recorded.

These complications are rare and late events, and may pass unnoticed. Driout and Duplant saw an ovarian cyst, which had been present for several years, suppurate in the course of typhoid fever. The pus was very abundant (10 litres), and contained the typhoid bacillus.

Lymphatic glands.—All the lymphatic glands are affected in typhoid fever, including the mesenteric, or extra-mesenteric, cervical, lumbar, inguinal, bronchial, etc.

The inflammation generally subsides fairly quickly. It is to its presence and persistence that we may attribute the paroxysmal cough, resembling pertussis, that may be observed in convalescence.

Suprarenal capsules.—According to E. Sergent the typhoid state presents certain symptoms, such as depression, prostration and hypotension, indicating *suprarenal insufficiency*, which in an aggravated form characterises the severe varieties of the disease, especially the adynamic and cardiac forms.

Acute suprarenal insufficiency may be manifested by a fall of the temperature and arterial pressure, bilious and greenish vomiting, profound prostration, and pain in the lumbar region which may simulate peritonitis.

The presence of suprarenal insufficiency may be detected by means of the *white line*, and above all by the result of treatment.

If the finger or a blunt object be drawn over the surface of the skin of the abdomen without exercising any pressure, in thirty to sixty seconds a white line is seen to appear, its width being greater than the blunt

object which caused it, and lasting from two to five minutes and even more, and never accompanied on each side by a pink line.

This is Sergent's suprarenal white line, which is the converse of the meningeal red streak, and may be regarded as a reflex spasm of the capillaries.

The suprarenal origin of this symptom appears to find a definite proof in the fact that adrenalin administered therapeutically causes the hypotension and the white line to disappear simultaneously. The therapeutic proof is without danger even in the course of acute peritonitis, and cannot fail to be of value both as a guide to diagnosis and as a remedy for the cardio-vascular asthenia.

Muscular System

The pathological anatomy of *typhoid myositis* is now well known, but its clinical signs are still indefinite. We are acquainted only with the lesions which result from it, such as muscular rupture, hæmorrhage and abscesses.

Muscular rupture is seen at the end of the third week or in convalescence.

It may be the result of a very slight effort (coughing, sneezing, etc.).

It occurs in order of frequency in the adductors and psoas, rectus abdominis and pectoralis minor, transversalis, muscles of the shoulders and the gastrocnemii.

It may pass unnoticed or be revealed by a sharp and sudden pain.

Hæmorrhage which follows rupture has no symptoms if it is deep and slight in amount; if superficial it is indicated by an ecchymosis.

When it is very profuse it may give rise to a soft and fluctuating hæmatoma, with or without an ecchymosis.

As a rule, the rupture and hæmorrhage clear up uneventfully, but the lesions may suppurate, as will be seen by local redness of the skin and fluctuation, as well as by a slight rise of temperature.

Osseous System

The irritation of the bony tissue in typhoid fever is revealed by exaggerated *growth* and the *lineæ albicantes*, due to elongation of the skin, which are seen in young patients when they leave their bed. But the most interesting phenomenon is the osteo-periostitis of convalescence (Chassaignac and Maisonneuve, Keen), which is chiefly met with in those patients whose osseous system has not yet attained its full development (Hutinel).

It is often multiple and symmetrical, and may affect any bone, but has a predilection for the long bones, especially the tibia.

Hutinel classifies the lesions of the periosteum as follows—

1. *Circumscribed periostitis.*—This is the most frequent form, but has attracted least attention because the symptoms are indefinite, of short duration, and complete recovery takes place.

2. *Osteo-periostitis ending in abscess formation.*—Fever, swelling of the bone at a definite spot, and redness and swelling of the skin, which gives passage to pus from a limited sub-periosteal abscess, either spontaneously or after incision.

This form always ends in recovery, but may last a very long time owing to the presence of sinuses and sequestra.

3. *Chronic periostitis* with gradual onset, resulting in deformity of the bone.

Pyæmic arthritis may affect the joints, constituting a primary localisation of the typhoid bacillus, but no special description of the symptoms is needed.

Polyarticular arthritis may also occur. Its very painful character and appearance at the onset of typhoid fever may cause it to be mistaken for acute articular rheumatism.

Lastly, *monoarticular arthritis* localised in the knee or hip is fairly frequent and is revealed by puffiness, swelling and pain, which end in recovery, ankylosis or spontaneous dislocation.

Skin

The skin of the typhoid patient is *warm* and *dry*. In the early hours of the morning it becomes damp and covered with *perspiration*.

In defervescence profuse sweats occur which have been called critical. Forms of typhoid fever have been observed in which the perspiration was so profuse that they were called "sweating fevers" (Borelli, Jaccoud). Perhaps these peculiar forms, which are so frequent in Southern Italy, result from an association with malaria, or are they really to be regarded as due to an infection by the *micrococcus melitensis?*

The palms and soles present a saffron-yellow colour (Filipowicz), but this is also found in other diseases. This *palmo-plantar sign*, as it is called, may be followed by *desquamation* of these regions in convalescence.

The desquamation may be more general and extend to all parts of the body, especially in young subjects (Roger). The hair often falls out.

Eruptions.—Various eruptions are met with in typhoid fever. One of them may be regarded as a specific clinical symptom, viz. the lenticular rose spots of Louis. The others are of secondary importance.

According to Murchison, the *lenticular rose spots* have a rose or pink colour, but which varies slightly in tint according to that of the patient's skin. Their form is rounded and regular, their margin is well-defined, and they measure from half a line to two lines in diameter. When the point of the finger is passed gently over the skin, each spot can in most cases be felt to be slightly elevated above the surface. Their outline is rounded or convex, but not acuminated. They are never indurated; but, in rare cases, a minute vesicle may be discovered at their apex. They are never converted into petechiæ; but during the whole period of their existence they disappear completely on pressure, and return when the pressure is removed.

The seat of election for the typhoid exanthem is

the thorax, abdomen, axillæ and sometimes the root of the thighs. Murchison often found them on the back, when they were not present anywhere else, and he occasionally noted that they were larger and more numerous on the back than on the front. The spots are developed in large numbers after a warm bath (Louis, Jenner).

In most cases the eruption appears on the seventh or eighth day. Exceptionally it is noted after the twentieth day (twentieth and thirtieth days according to Louis, and forty-fifth and fifty-second according to Rilliet and Barthez). After the fall of the temperature it is a premonitory symptom of a relapse.

An early appearance, before the seventh day, is as rare as a late eruption, and seems to be an accompaniment of severe and exceedingly acute forms.

The eruption is, as a rule, discrete. The spots are not very numerous at once; they appear, without any order, in successive crops, in groups of three or four, and then disappear to give place to others. The average duration of each spot is from three to five days.

The eruption lasts five to seventeen days, ten on the average. There are spots, however, which persist abnormally for ten, fifteen and even twenty days, and leave, on fading, a dark deposit of pigment or copper-coloured macule. In those cases in which there was a minute vesicle in the centre of the spot, a slight desquamation occurs at the former site of the vesicle. Certain spots are transient and disappear in one or two hours. As a rule, they are not numerous (ten to twenty at a time), and in some cases they are rarer still. It may be possible to find only three or four, or even less.

Occasionally the eruption may be so profuse as to imitate the exanthem of measles.

In subjects with a white and fine skin the lenticular eruption is sometimes preceded by a hyperæmia which sometimes produces a continuous redness, and some-

times a punctate rash limited to a narrow portion of the integument. In such cases it may be mistaken for scarlatina.

In severe forms the spot changes its tint and grows paler as the adynamia increases. A similar phenomenon occurs at the moment of death. Not only is the eruption never to be found on the corpse, but, in a patient who succumbed when the rash was fully developed, the eruption disappeared in a few hours before the terminal collapse (Cheurlot). The eruption is never completely absent. In cases in which no lenticular rose spots have been found, they may possibly have escaped notice for various reasons, *e. g.* small number, transient duration, unusual site, peculiar colour of the skin, unusually early or late development, etc.

Other eruptions may be found in typhoid fever, *e. g. purpura*, which is always of grave prognosis, and *erythemata*, *mild* or *severe*.

In addition to the eruption, which may be polymorphous, morbilliform or scarlatiniform, the severe cases are characterised by a grave adynamic general condition, a fall of temperature with re-ascent, vomiting of greenish fluid, green and fœtid diarrhœa, and ulcerations of the lips and nose. The prognosis is grave (a mortality of 60–80 per cent.).

The well-known pearly vesicles called *sudamina* are very common. They are situated on the front of the thorax, on the abdomen, neck and axillary regions. They may be more or less confluent, but, as a rule, are fairly discrete.

Gangrene of the skin is fairly frequent. It usually occurs in those parts of the body which are for long subjected to continuous pressure. Examples are seen in the sloughing of the skin over the sacrum and ischium, elbows, heels and scapulæ. They are not so frequent as formerly. They occur at the end of the second week, or in the third or fourth in severe attacks, or in subjects, exhausted by hæmorrhage or profuse diarrhœa, who *have not received proper attention*. They may be the starting-point of many more or less severe

complications such as multiple abscesses, gangrene, erysipelas, etc.

In addition to the serious *typhoid pyæmia*, writers have recorded cases of *furunculosis* and *subcutaneous abscesses* succeeding one another in large numbers for a long period so as to resemble glanders (Lailler).

CHAPTER III

CLINICAL CHARACTERS OF PARATYPHOID FEVERS A AND B

In spite of the similarity of their clinical symptoms, and even of their anatomical lesions, paratyphoid fevers constitute morbid entities quite distinct from typhoid fever. An attack of typhoid fever does not confer immunity against an attack of paratyphoid fever, or vice versa. Since the important investigations of Achard and Bensaude in 1896, the clinical and bacteriological history of paratyphoid infection has grown considerably. The paratyphoid A and B bacilli, like the typhoid bacillus, are able to produce not only general infections of a septicæmic type, but also infections which are localised from the first. Belonging to the same family of bacteria as the typhoid bacillus, but nevertheless differing from it, the paratyphoid bacilli play a similar rôle to the typhoid bacilli in infections of the liver and bile ducts. The ordinary clinical forms of paratyphoid A and B resemble those of typhoid fever, and it is always by comparison with the latter that a diagnosis has hitherto been made. It was held that paratyphoid fevers in the great majority of cases assumed an attenuated "typhoid" form.

Paratyphoid fevers, which had been comparatively rare in France before the present war, have since become very frequent, especially since August 1915.

As accurate diagnosis became more frequent by discovery of the specific infective agent, it was realised that paratyphoid fevers had usurped their reputation for benignity, which was perhaps due to a purely clinical diagnosis.

At the present time it is agreed that paratyphoid fevers A and B may assume all the symptoms of typhoid fever and realise every clinical type. They may even present the same complications, which, though possibly less frequent in paratyphoid fevers, are equally severe.[1]

For this reason it would be difficult to give here any clinical signs which in themselves would be sufficient to allow an exact diagnosis to be made between typhoid fever and paratyphoid fevers A and B. This diagnosis the laboratory alone can establish undoubtedly by means of an early blood-culture.

The *incubation period* in paratyphoid fevers varies considerably; on the average it is from nine to fifteen days, but it is sometimes shorter, and may be reduced to five or six days (Sacquépée), four to five (Dibos), or three to eight (Lenglet).

The phenomena of onset resemble those of typhoid fever of a mild form, viz. great lassitude, insomnia, headache, epistaxis, nausea, anorexia, thirst, pain in the back, orbits and nape of the neck, cramps in the calves, etc.

Shivering has been noted as fairly constant at this period (H. Vincent, Job, Robinson), and is sometimes repeated for several days. Constipation is very frequent (Sacquépée, Chevrel), but diarrhœa is not rare (Meslay and Coville, Job), being met with in about one out of two cases (Lenglet, Coyon and Rivet, etc.). Boidin and Burnet judiciously remark that "in the course of this war paratyphoid fevers have often supervened in cases of prolonged diarrhœa which have lasted three or four weeks without fever."

The stools in paratyphoid usually have a putrid odour (Job) and a more or less ochre colour; they contain greyish fragments of desquamated and putrefied intestinal mucosa (H. Vincent). They do not leave the

[1] It will be remembered that the lesions found at autopsy may be identical in paratyphoid fevers and typhoid fever. Ulceration of Peyer's patches and perforative peritonitis, however, are less frequent in paratyphoid fevers A and B.

same coloured stains on the sheet and bed linen as the typhoid stools (Landouzy).

The onset of paratyphoid fevers is often slow and progressive (Boidin and Burnet, Coyon and Rivet, Robinson, Grenet and Fortineau, Netter and Ribadeau-Dumas, etc.). But, more frequently still, it may be sudden, with shivering and vomiting which mark the onset of the infection (Grenet and Fortineau, Chevrel, Job, Rathery, etc.).

The patient may then fix the exact moment at which he noticed the first symptom.

In three or four days the temperature reaches its maximum, which is about 104° F. (Job, Lévi-Valensi, Netter and Ribadeau-Dumas, Chevrel, etc.). Vomiting is frequent, the patient may not be able to keep anything in his stomach. Severe headache, pain in the back, and *occipital pain*, which may even precede the febrile symptoms, have been noted as fairly common during this initial period. Sometimes the onset may be dramatic and simulate meningitis (Job, Netter and Ribadeau-Dumas), or appendicitis (Grenet and Fortineau), and be accompanied by extreme prostration, by convulsions in children, and by vomiting at all ages (Job, Robinson, etc.). The patient very soon begins to resemble a case of typhoid fever of the end of the first week. He preserves the congestion of the cheeks and conjunctivæ noted by Murchison as one of the symptoms of typhoid fever. The tongue is dry and coated, the gums are covered with a pultaceous deposit, and the throat is red. Labial, facial and buccal herpes is frequently observed (Vincent, Aubry, Job, Chevrel): some writers, however, have seldom met with it (Coyon and Rivet). *Sore throat* is not exceptional. Duguet's *ulcerations* have been found. At the onset of the disease the patient fairly often suffers from colic and *diffuse abdominal pain* on pressure, without special localisation in the right iliac fossa (Vincent). This pain may last for one or several days. Sometimes pain and *gurgling* have been noticed in the right iliac fossa (Netter and Ribadeau-Dumas, Robinson). Jacquement

states that " complete absence of pain or tenderness in the right iliac fossa should make one think of paratyphoid conditions." The *abdomen* is sometimes distended. The *liver* is almost always increased in size, and sometimes to a degree rarely observed in typhoid fever (Chevrel). The *spleen* is less big than in typhoid fever (Landouzy), whereas, according to other writers, it is always much enlarged (Job, Meslay and Coville, Chevrel), so that its edge can be felt several fingers' breadths below the false ribs (Aubry).

Sweating is frequent and sometimes profuse, occurring late in the evening or in the night.

The *lenticular rose spots* which Landouzy regards as inconstant are present in 60 per cent. of the cases (Robinson). They may be rare, or, on the contrary, remarkably plentiful, appearing in successive crops, sometimes involving the face (Chevrel), and extending over the neck, cheeks, arms, forearms, and leaving only a few small areas of healthy skin (Grenet and Fortineau).

In several cases a *buccal enanthem* has been found (Grenet and Fortineau, Petges, Dumora and Peyri). The rose spots sometimes assume the papular type (Meslay and Coville), which is rare in typhoid fever. They may be large and of short duration (René Benard). Their colour is sometimes dark or violet pink, with, occasionally, a central point in which the colour is more pronounced (Lenglet). They have been seen to appear after complete fall of the temperature (Chevrel), and to last for several days during apyrexia (Vincent).

The *typhoid state* is usually ill-marked (Job, Landouzy, Boidin and Burnet, Coyon and Rivet, etc.). Some have found more pronounced *nervous symptoms* than in typhoid fever, whereas, according to others, these symptoms are either absent or ill-marked (Étienne, Jeandelize and Soncourt). Ataxo-adynamic forms, however, are not exceptional. Cases have been observed of hemiplegia with sensory troubles, without aphasia, psychosis of the mental confusion type with

oneiric delirium (Raymond, Parisot and Orticoni), psychoses with post-oneiric ideas (Merklen), sphincter troubles; retention or incontinence of urine, incontinence of fæces (Merklen), neuritis of the vagus, paresis of the deltoid, diminution of the reflexes, ankle clonus and acute encephalitis (Job). The *urine* is scanty and dark. Albuminuria is present in half the cases (Aubry), but is slight and of short duration (Job, Raymond, Parisot and Orticoni).

According to Aubry, the *diazo-reaction* is generally absent; whereas, according to others, it is fairly frequently positive.

The pulmonary signs are very slight; mild bronchitis is merely found in most of the cases (Chevrel, Aubry).

In soldiers, in the course of this war, there have generally been found congestion of the bases, acute or prolonged in character, congestion of the apex, simulating tuberculosis, in which the patient expectorates numerous paratyphoid bacilli in the sputum, pleuro-pulmonary congestion, broncho-pneumonia (Raymond, Parisot and Orticoni), and pneumonia with splenization (Minet). The hæmatological formula does not differ from that of typhoid fever.

It was generally thought that the heart was rarely affected in paratyphoid, and that one could only find bradycardia and extra-cardiac murmurs, and never tachycardia. J. Minet, in 19 out of 60 cases, observed more or less marked myocardial manifestations.

He found the same clinical types as in typhoid myocarditis—

(1) *Latent forms*, most frequently met with, in which affection of the myocardium was revealed only by examination of the heart and pulse.

(2) *Grave forms*, in which disturbance of the circulation indicated the failure of the cardiac muscle.

(3) *Syncopal forms*, rare, in which sudden death might be the first and only symptom.

(4) *Chronic forms*, also rare, following the acute phenomena.

In 7 out of 19 cases this author found tachycardia,

and in 11 out of 19 embryocardia. In this connection he remarks that fœtal rhythm, which is of grave prognosis in the typhoid patient, has not the same significance when it appears *as the only cardiac sign* in paratyphoid fever. It assumes the character of a grave sign only when it is accompanied by other indications of cardiac failure.

The *temperature* rarely exceeds 104° in the ordinary

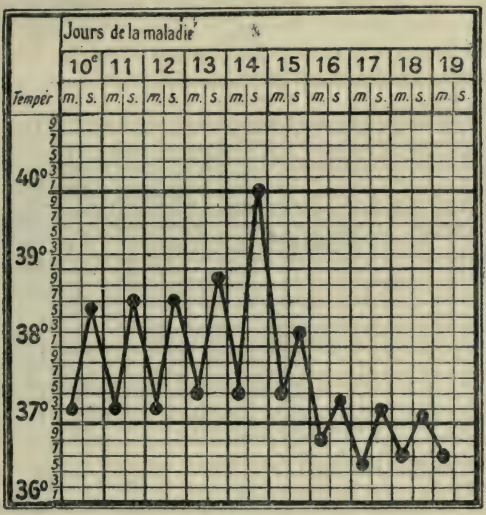


FIG. 8.—Boy, aged 13½. Paratyphoid fever A.

forms. Its curve may be exactly like that of typhoid fever with a period of ascending oscillations. But, as a rule, the fastigium is reached in two or three days. The height of the disease is often of very short duration. In eight or ten days (Job), or seven to fifteen (J. Lévy-Valensi), the temperature falls to normal by lysis. This return may be more rapid still, taking only two or three days (Aubry).

In such cases the temperature curve does not show a plateau. Sometimes, however, the plateau is present,

and in severe cases may be as high as 102·2° or 104·0°, sometimes it keeps about 100·4°.

Shortened forms of paratyphoid fever are to be met with, which probably include a certain number of the cases which were formerly described as febrile gastric derangement, or gastric fever.

The *pulse* closely follows the temperature. Its maximum varies, on the average, from 80 to 100, or 120. As a rule, it appears to undergo a marked slowing in the period of apyrexia, falling to 60 beats in the minute, and often less—52, 48, 34 (J. Lévy-Valensi).

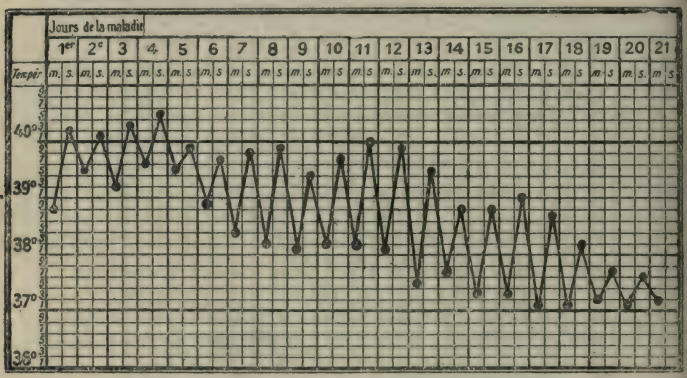


FIG. 9.—Girl, aged 12½. Paratyphoid fever B.

Generally speaking, the pulse appears to be slower than in typhoid fever (Robinson). Dicrotism, also, appears to be rarer.

The course of paratyphoid fever is shorter than that of typhoid, and, as a rule, its total duration is less than a fortnight (Chevrel, Meslay and Coville, Robinson, Dévé, Job). But, according to certain authors, it may be as long—three to four weeks, on the average, rarely less, but often longer, according to Aubry, Coyon and Rivet.[1]

[1] According to Merklen and Trotain, the duration of the disease is in relation to the age of the patient: twenty-four to twenty-seven days for the ages twenty to thirty, and twenty-seven to thirty-two days for the ages thirty-one to forty-six.

Netter and Ribadeau-Dumas have recorded cases in which the temperature did not become normal until after more than three months.

These cases are not exceptional. During this long period it seems, as these writers say, that there is a succession of several attacks. These may follow so closely one upon the other that there cannot be a question of relapses; or, on the other hand, several days of normal temperature may intervene between the attacks.

Relapses are found to be as frequent as in typhoid fever (10 per cent., according to Rimbaud; more

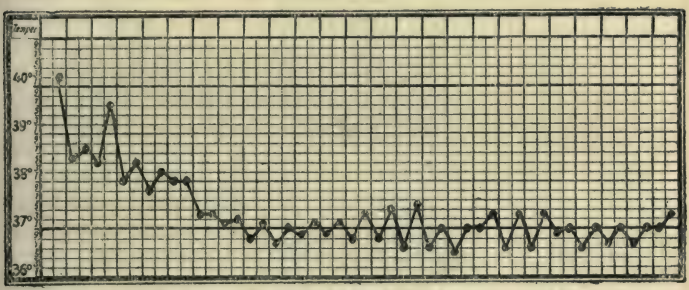


FIG. 10.—Mild paratyphoid fever B. Positive blood culture. (Rathery.)

frequent still, according to Grenet and Fortineau). According to Job, recrudescences are more frequent than relapses.

The onset of convalescence is frequently marked by polyuria.

The hypothermic phenomena are rarely so marked as those preceding the termination of typhoid fever, but sometimes the amphibolic stage is much more pronounced, especially in paratyphoid A (Coyon and Rivet). It was for a long time thought that the course of paratyphoid fevers was mild, and that complications were exceptional. But it has been found that in war time these diseases fairly frequently present grave and complicated forms.

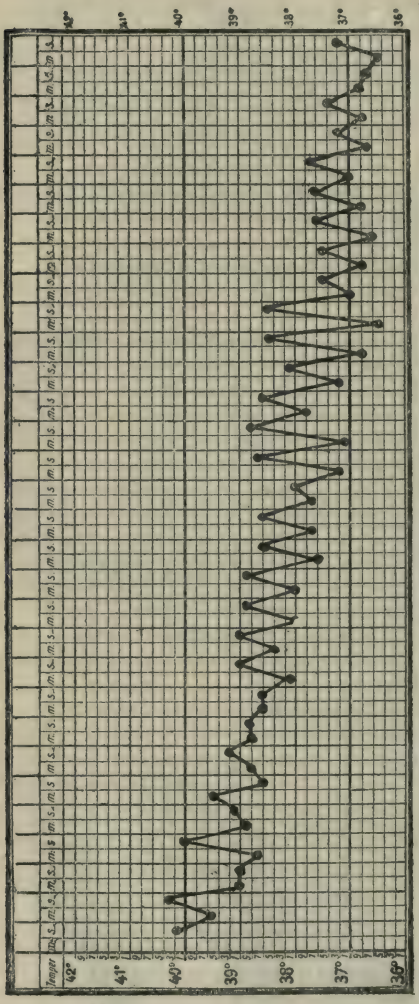


FIG. 11.—Paratyphoid fever B. Positive blood culture. (Rathery.)

The adynamic form is fairly frequent, especially in paratyphoid A (Boidin and Burnet). But an ataxo-adynamic form of paratyphoid B has also been observed.

Intestinal hæmorrhage is not rare, being accompanied by alarming symptoms such as fainting attacks, cold sweats, feeble pulse, etc. It may recur for several days in succession, or reappear after an interval of a fortnight (J. Minet). It seems to be less severe than in typhoid fever, but it may be fatal. It is observed in 5 or 6 per cent. of the cases.

Coyon and Rivet, in a case of paratyphoid B diagnosed by a blood-culture, noted a case of death after twelve days of peritoneal

symptoms. It was an instance of *peritonitis without perforation.*

Félix Ramond and Schultz published a similar case, which occurred on the 15th day of paratyphoid A, which had been diagnosed by a blood-culture and appeared to be a mild case. The patient died after peritoneal symptoms lasting for seven days, a fall of temperature to 97·4°, painful and retracted abdomen, diminution of the urine, and a pulse of 100. No blood in the stools. Median laparotomy. Death from cardiac collapse. No perforation. Collection of pus in the right flank. Bourges has observed *intestinal perforation* occurring insidiously in paratyphoid, and without any of the ordinary symptoms of peritonitis. Grenier, Hornus in Morocco, Raymond, Parisot and Orticoni have also seen cases in the course of paratyphoid A and B.

Raymond, Parisot and Orticoni have noted the great frequency of *phlebitis.* They found seventeen cases in the left lower limb, seven in the right lower limb, and one in the left brachial vein. Death occurred after broncho-pneumonia from a suppurative infarct; the starting-point was a thrombus in the right iliac vein. J. Minet has seen two cases of phlebitis, one in the femoral and one in the brachial vein.

The kidneys and bladder may be severely affected. Cases of extremely abundant albuminuria in paratyphoid A, and of hæmaturia in paratyphoid B, have been reported by Raymond, Parisot and Orticoni.

The respiratory system may be the seat of grave complications.

Giroux noted, in the course of paratyphoid A, a pleurisy which was at first serous and later purulent and hæmorrhagic. Pleuro-pulmonary congestion of protracted course is fairly frequent, with an effusion containing neutrophil polymorphonuclears.

E. Joltrain and G. Petitjean had the opportunity of seeing nineteen cases of pleurisy among 310 cases of paratyphoid fever in soldiers (6 per cent.); eighteen were due to the paratyphoid B bacillus, and only one to the

paratyphoid A bacillus. Fifteen were sero-fibrinous, two were purulent, and two dry. As a rule they appeared in the course of latent or abortive forms, in which they were sometimes the first symptoms (pleuro-paratyphoid).

In addition to the complications affecting the nervous system already noted, we may mention a case of typical tetany which occurred in a patient on taking a warm bath. In childhood he had had repeated convulsions. He remained a subject of spasmophilia. Tetany was present in him potentially, and a general disease, such as typhoid fever, was sufficient to render it patent (Bedos, Babonneix and Corone).

Parotitis, simple or suppurative, is not extremely rare. Sabrazès has published a case of suppurative myositis of the right pectoralis major due to the paratyphoid A bacillus.

Catarrhal or suppurative otitis is fairly frequent, as well as suppurative lesions in the bones and joints. Lesions of the liver and gall-bladder (hepatalgia, hepatomegaly and angiocholecystitis), certain very painful forms of which seem to give rise to peritoneal symptoms, have been noted in 80 per cent., either in the course of the disease, or after the fall of the temperature, by Raymond, Parisot and Orticoni. Lastly, the same authors recorded a case of orchitis with suppuration in the tunica vaginalis, and Giroux had a case of orchi-epididymitis with suppuration and elimination of the affected testicle.

We can see by the foregoing description, first, how closely allied are paratyphoid fevers, by their symptoms and complications, to true typhoid fever; and, secondly, how we can only admit with reserve the mild character hitherto attributed to the two paratyphoid fevers.

They are certainly less frequently fatal than typhoid fever. Statistics, however, confirm their degree of gravity during the war.

Merklen and Trottain diagnosed by blood-culture and treated 446 paratyphoid fevers, 356 of which belonged to type A, and 90 to type B.

They had fifteen deaths, ten of which occurred in paratyphoid A and five in paratyphoid B. The causes of death were the following: broncho-pulmonary complications, six cases; intestinal hæmorrhage and perforation, three cases; virulence of infection, icterus and parotitis, two cases; cardiac collapse, uræmia, meningitis, and diphtheria, one case each.

Grenet and Fortineau diagnosed by blood-culture seventy-six cases of paratyphoid A and twelve of paratyphoid B. They had three deaths, two in paratyphoid A from intestinal perforation and myocarditis, and one in paratyphoid B from intestinal perforation.

Dévé, in 201 positive blood-cultures, found 140 cases of paratyphoid A and sixty-one of paratyphoid B. His mortality was 0·7 per cent. for paratyphoid A and 1·6 per cent. for paratyphoid B.

These statistics, like those of Sacquépée, Burnet and Weissenbach, Leger, Abt and Dumont, Nobécourt and Peyre, and J. Carles, show that in the army in campaign paratyphoid A fevers are much more frequent than paratyphoid B. In certain regions, however, paratyphoid B has been predominant. The same statistics, as well as those of Benard, Dibos, etc., also prove that paratyphoid fever A is less severe than paratyphoid fever B. Before the war of 1914 paratyphoid fevers were extremely rare in the French army, in which doubtful cases were examined by a blood-culture.

As Prof. Landouzy remarks, complications, judging by the cases published, seemed exceptional, especially intestinal hæmorrhage and perforation. But the excessive predisposition which the war provoked for diseases of typhoid form, hæmorrhage and perforation in the course of this war have become as frequent as in typhoid fever. The first two statistics quoted above further show that out of 584 authenticated cases of paratyphoid, of which eighteen ended fatally, five deaths were due to *intestinal hæmorrhage* or *perforation*, a mortality of 0·93 per cent., and that these complications were present in more than a quarter of the fatal cases.

Among 170 cases of paratyphoid there were eight deaths. J. Carles had two deaths from intestinal hæmorrhage and one from perforation, *i.e.* more than a third of the deaths were due to these causes.

Paratyphoid fevers, however, include a number of attenuated forms which may pass unnoticed by the doctor, or even the patient. Prof. Landouzy has insisted on this point. "Many morbid episodes, hitherto described by nosographers as mild typhoid, mucous fever, febrile gastric derangement, are probably the result of infection by one of the paratyphoid bacilli." There are perhaps very few combatants who did not present these diminutive attacks of paratyphoid infection, in the form of colic, pains in the body and limbs, and fever, for a few days. It is not less probable that before the period of bacteriological diagnosis numerous pathological states described by the name of *typhoid fever* with sudden onset, or with abdominal, pleural or hepatic complications were really due to infection by the paratyphoid bacilli A and B.

The identity of the symptoms observed in these diseases—which constitute, nevertheless, distinct processes, and do not confer reciprocal immunity—easily explains the confusion. It may be said that without the aid of the laboratory the exact diagnosis of typhoid fever, or of paratyphoid fever A or B, cannot be established.

The same statement applies to bacillary or amœbic dysentery, meningococcal, parameningococcal or pneumococcal meningitis, and to diphtheria and pseudo-diphtheria.

The infected organism cannot, indeed, oppose an unlimited number of reactions to micro-organisms which are more or less related to one another, like the typhoid and paratyphoid bacilli. Besides this more or less severe typhoid form, with its features which we will summarise later, certain forms have been described which are peculiar to paratyphoid.

The *mild form*, which closely resembles *febrile gastric derangement*, is characterised by digestive troubles

such as anorexia, vomiting and diarrhœa, with a more or less intense febrile state. The onset is sudden and the course rapid. Discrete *lenticular rose spots* may be seen.

Some of these infections which bear only a distant resemblance to typhoid fever, except in the presence of rose spots, are so mild that it has not seemed necessary to the patient to stay in bed. They have received the name of "ambulatory paratyphoid" (Chevrel).

The *gastro-intestinal form*, which is usually due to intoxication of alimentary origin, presents variable symptoms according to the gravity of the infection. In these cases it is the paratyphoid B bacillus which is the cause, or the *Bacillus enteritidis*, which belongs to the same group of the Salmonelloses. The morphological, cultural and biological properties, as well as the pathological features of the Bacillus enteritidis are exactly those of the paratyphoid bacillus B, from which it can only be separated by its reaction towards agglutinating serums (Rieux and Sacquépée).

The symptoms due to these alimentary infections generally begin shortly after the suspected meal, on the average in twelve to thirty-six hours, sometimes sooner and sometimes later; the extreme limits are one hour and four days. In the same epidemic the incubation period may vary, according to the individual, from one or two hours to two days, but as a rule it is the same for all, so that one may witness a veritable explosion, which is often dramatic in its intensity. In very mild cases the patient has headache and diarrhœa, as well as some pains in the limbs, presents more or less marked asthenia, and sometimes shows a slight rise of temperature. Two or three days afterwards he is cured. If the attack is a little more severe, the preceding symptoms are a little more marked and accompanied by colic and vomiting. The stools are numerous, liquid, greenish, blackish or brownish in colour, and of very fœtid odour. Vomiting, which is at first alimentary, becomes bilious and sometimes bloody. The patient is obnubilated, sometimes pros-

trated. His temperature is not high, as a rule, but may reach 104·8° (Vagedes). All these symptoms vary in duration, lasting two, three or eight days, sometimes even a month or two, and even more.

Recovery is the rule, but even in mild cases convalescence is often protracted and tedious.

"When the attack is still more severe it almost always assumes the appearance of *cholera nostras*. The stools, which are often liquid and even of the rice-water character, occur ten to thirty times in the forty-four hours, and are accompanied by persistent vomiting; the small and rapid pulse, pallor of the face and anxiety, peripheral algidity and tendency to collapse, prostration and cramps, remind one of cholera; the temperature varies and is fairly often below normal" (Sacquépée).

In E. Sergent's case the resemblance with cholera was even more striking. After choleriform symptoms of the most alarming character for three days the temperature rose and kept between 103·2 and 103·6° F. for seven days. During the course of the intoxication the most abnormal symptoms may arise, such as myosis, conjugate deviation of the eyes (Tiberti), mydriasis, aphonia, incontinence of the anal sphincter, anuria, purpura (van Ermengem), *rose spots* (Cahn), herpes, etc.

Icterus is exceptional according to Curschmann, but frequent according to Audry, and is shown by pigmentation of the skin and urine, clay-coloured stools and increase in size of the liver and spleen.

Lastly, some forms resemble dysentery with tenesmus, colic and very numerous bloody stools (Jacobson).

The choleriform attacks usually run a fairly rapid course lasting a few days, rarely more than a week (Job, Audry).

In the course of the same epidemic these different forms may be seen in existence simultaneously.

In peace time the mortality is low. In a total of 2725 cases consisting of the most different types Sacquépée found only four deaths—a mortality of 1·5 per cent.

Persons who have had typhoid fever and who have been vaccinated against it are by no means immunised against the paratyphoid fevers A and B, but may contract paratyphoid fevers which run an ordinary course.

CHAPTER IV

DIAGNOSIS

It is of the utmost importance to make an early diagnosis in typhoid and paratyphoid fevers, both in the patient's interest so that treatment may be commenced as soon as possible, and in the interest of the community so that the necessary prophylactic measures may be taken.

We have already said that by unaided clinical observation only a presumption could be formed as to the existence of one or other of these affections. An exact differential diagnosis is only possible by the help of the laboratory. But this it may be impossible to obtain. We will, therefore, devote the first section of this chapter to a description of the principal rules for the clinical diagnosis of typhoid fever and paratyphoid fevers.

In the second section we will study the laboratory methods, which enable us to make a diagnosis by the isolation and identification of the causal agent of the infection or by the study of the specific humoral reactions produced in the organism by this agent.

I. Clinical Diagnosis.

At the onset the clinical symptoms which might guide the diagnosis are common to all infections. Individually they have only a very relative value, but collectively they gain in precision and may make one suspect typhoid fever. During the first week the diagnosis will be guided by the malaise, peculiar type of headache, insomnia, epistaxis, slight bronchitis, coated tongue,

or diarrhœa with special characters, pain on pressure in the epigastrium, or right iliac fossa, with gurgling, and fever with evening exacerbations which become more intense each evening.

If after a week of this state of affairs the spleen becomes enlarged and lenticular rose spots appear, there can be no doubt about typhoid fever, whatever the other symptoms may be (Homolle). A much more sudden onset, with a temperature of 103·2° F. on the second or third day, shivering, vomiting and the appearance of herpes, should make one think rather of paratyphoid A or B. In making a diagnosis at this period one should take into account the existence of an epidemic, the non-acclimatisation of the subject, his age and the life he has been leading, as well as his pathological antecedents (previous attack of typhoid or paratyphoid fevers).

At the height of the disease the gastro-intestinal symptoms, further increase in the size of the spleen, eruption of lenticular rose spots, but most of all the typhoid state, will be the principal elements in the diagnosis. These symptoms and their diagnostic value have been studied at length in a previous chapter.

There is no pathognomonic clinical feature in paratyphoid fevers, either to distinguish paratyphoid fever A from paratyphoid fever B, or to distinguish between paratyphoid fevers and typhoid fever properly so called.

Paratyphoid fevers may present all the symptoms and all the complications of typhoid fever. However, one may be guided in the diagnosis, though not constantly, by certain signs, among which the following are the most frequently observed—

(1) The suddenness of the onset, with vomiting and shivering.

(2) The frequency of pain in the occiput at the onset.

(3) The early eruption of labial, facial or buccal herpes.

(4) An ill-marked typhoid state.

(5) A fairly frequent meningeal reaction.

(6) Slight degree of diarrhœa, constipation the rule.

(7) Frequency and intensity of perspiration at the onset or in the course of the disease (paratyphoid fever A and B).

(8) The sometimes remarkable, though not invariable, abundance of lenticular rose spots, which may appear at the onset of defervescence and last for some days later.

(9) The frequent and considerable enlargement of the liver.

(10) Shorter course of the disease.

We must, however, insist on the fact that these symptoms are not constant, that they may exist separately, and that, finally, many of them have been found in genuine typhoid fever.

The only clinical character which differentiates paratyphoid fevers is that on the whole these are less severe, and accompanied by a lower mortality than typhoid fever.

The diagnosis of typhoid fever, though easy in some cases, may be very difficult in others. The symptoms may not be sufficiently prominent, especially at the onset. There may be an absence or alteration of some cardinal signs or a predominance of others which are of secondary importance in typical typhoid fever.

At the onset one may think of influenza or the eruptive fevers in children, especially measles.

Influenza generally has a sudden onset. The prodromal period, when present, is shorter than that of typhoid fever, even with a sudden onset. The temperature often rises suddenly to 104° and even 105·8° F., but does not keep long at this level. Sometimes it drops suddenly after two or three days and does not rise again; sometimes, after a remarkably sudden fall lasting for twelve to twenty-four hours, it rises as high again as before the fall, thus forming a depression like an upturned bell (the influenzal V of J. Teissier), and sometimes it descends by lysis.

According to Jaccoud, one may find insomnia,

epistaxis, delirium and ochre-coloured diarrhœa in the intestinal forms, and even hæmorrhage from the intestine (?).

The patient may present the typhoid aspect, an increase in size of the spleen, scarlatiniform and morbilliform rashes and papular eruptions (Van Swieten, Comby, Perrenot), sore throat, with redness of the pharynx and swelling of the tonsils.

But the diagnosis can be made by the oculo-nasal catarrh, arthralgia, neuralgic character of the headache, which is frequently supraorbital, frequent perspiration, and, lastly, the course of the temperature and absence of lenticular rose spots.

The history of an epidemic will be a help. One must, however, bear in mind a possible association of typhoid fever and influenza (Hérard, Moissenet, Potain).

Eruptive fevers, such as measles, smallpox or scarlatina, have a special symptomatology in the prodromal period which will, as a rule, allow them to be excluded.

In every case all doubt will be removed by the special form of the eruption when associated with a history of contagion and an epidemic.

There are numerous diseases which borrow from typhoid fever its two chief signs in the fully developed stage (viz. fever and the typhoid state), and which may cause errors in diagnosis.

Few medical men in France have seen *typhus fever*, which is characterised by its sudden onset, a temperature of 104° or 104·8° F. on the first day, with a pulse between 100 and 120, constipation with an absence of intestinal symptoms, frequent and profuse epistaxis, vaso-dilatation of the conjunctivæ (an important symptom), nasal mucosa, and upper respiratory tract, and almost constant vomiting (Bué).

The eruption of typhus appears early, being constituted by red or pink spots, which are papular and slightly elevated, disappearing at first on pressure, and appearing first on the abdomen and then invading the whole body, except the face.

After one or two days the eruption becomes darker, and the red spots become transformed into *petechiæ*, which no longer disappear on pressure.

The delirium is very violent, with a tendency to suicide, and at the end of two or three days the patient falls into a state of extreme torpor, with a congested face. In favourable cases the termination is sudden. Typhoid fever is distinguished from typhus by its slower onset, the later appearance of its eruption, which is never petechial, by the presence of intestinal symptoms, and usually by the less degree of the typhoid state.[1] If one also takes into account the highly contagious and dangerous character of typhus, it will not be confounded with typhoid fever. A blood-culture will often aid in the diagnosis.

In the first rank of febrile infections of a continuous type which may simulate typhoid fever are to be placed two forms of acute tuberculosis: miliary tuberculosis and the *typho-tuberculosis of Landouzy*.

Acute miliary tuberculosis has a less regular temperature curve, frequently showing great oscillations and sometimes assuming the inverse type.

The pulse, which is more rapid than in typhoid fever, is rarely dicrotic and closely follows the temperature. The pulmonary signs are more marked and accompanied with intense dyspnœa.

Photophobia is frequent, the digestive symptoms are less intense, the tongue remains moist for a long time, being only slightly coated, the appetite fairly often is only diminished. The abdomen is flattened or scaphoid, without any pain or gurgling, rose spots are quite the exception, the typhoid state is much less pronounced, and there may be muscular and cutaneous hyperæsthesia.

[1] In war time, however, the gravity of the general signs of typhoid fever and the symptoms of torpor are sometimes so marked that the mistake has been made. The purpuric or hæmorrhagic character of the rose spots has also suggested typhus. But in such cases cultivation of the blood during life, or of the bile after death, has yielded the typhoid bacillus.

On the other hand, the spleen may be enlarged as in typhoid fever.

The typho-tuberculosis of Landouzy bears a great resemblance to typhoid fever, especially at the onset. Its onset is slow and progressive, with pains in the limbs, headache, epistaxis, slight shivering, abdominal disturbance, occasional vomiting, constipation or diarrhœa.

There are no lenticular rose spots, however, nor ochre-coloured diarrhœa. The temperature shows great oscillations, which may be as much as 2·6 or 3·6° F. The dyspnœa is very intense in contrast with the lesions detected. A pleural localisation may occur towards the third or fourth week. It must not be forgotten that typhoid fever may present the same lesions or wake into activity latent tuberculous lesions of the pleura.

The infections due to Thiercelin's *enterococcus* are usually mild, but may be abnormally protracted and give rise to irregular pyrexia with headache, thickly-coated tongue, vomiting, abdominal meteorism, and profuse diarrhœa. The spleen is somewhat enlarged. There are no rose spots. But typhoid fever may be simulated by the duration of severe attacks of enterococcal infection, which may last two or three weeks or more. Diagnosis can be made by a blood-culture.

Mediterranean fever (melitococcus infection, Malta fever) starts like typhoid fever, and may frequently be mistaken for it at the onset.

The patient complains of headache, pain in the limbs, and loss of appetite; the tongue is coated, vomiting is not uncommon.

Furthermore, a progressive rise of temperature with a morning remission is observed. Pains in the joints are frequent. Attention should be aroused by the obstinate constipation, and sweating at each morning remission. The patient is pale and asthenic, and the spleen is slightly enlarged. Defervescence occurs by lysis, and apyrexia becomes complete in about three weeks, but is not permanent. A fresh rise of tempera-

ture, similar to the first, occurs some days later, then a third, and so on.

The disease generally ends by recovery, but may last two or three months, one or two years, or more. It is characterised by the temperature curve, which has given it the name of "Undulant fever," or "fever with relapses." It is obvious that a diagnosis based exclusively on this temperature is too late to be of use.

Blood-culture and Wright's serum test (performed with an emulsion of a pure culture of the *micrococcus melitensis* on agar) may be carried out early in the disease, the specific agglutinins appearing on the fifth day.

In hot countries, especially along the Mediterranean coast (Salonica, Greece, Turkey, Syria, Asia Minor, etc.), *malaria* often assumes a *continuous* type, with digestive disorders, dry and coated tongue, bilious vomiting, diarrhœa, swollen and tender liver, large spleen, headache, insomnia, etc. The febrile state is prolonged in patients who are not treated with quinine. These forms of so-called tropical malaria, which are sometimes very severe, are often confounded with typhoid and paratyphoid fevers. Their onset is usually sudden. The temperature is irregular (except in the remittent type). There are no rose spots. The blood culture for typhoid and paratyphoid bacilli is negative. Examination of the blood shows an occasionally considerable proportion of schizontes and gametes. Lastly an energetic quinine treatment (2 grammes of hydrochlorate of quinine daily or two subcutaneous injections) causes a rapid disappearance of the symptoms.

It should not be forgotten that typhoid or paratyphoid fevers may be associated with malaria (typho-malarial fever).

Acute articular rheumatism may sometimes simulate typhoid fever and begin with sore throat, shivering, pains all over the body, epistaxis and fever. Sometimes it assumes an ataxic and adynamic form like severe typhoid fever. But the patient sweats profusely,

and the localisation of the pain in the joints soon forms a guide to the diagnosis.

Icterus gravis begins with symptoms which simulate the onset of typhoid fever. After a few days of malaise, pains in the limbs, headache, myalgia, and fever, or after some vague gastro-intestinal disturbance, jaundice develops, which may be insignificant or pronounced. But soon various hæmorrhages are observed, such as epistaxis, hæmaturia, hæmatemesis, intestinal hæmorrhage, purpura, ecchymosis, etc., accompanied or followed by more or less intense nervous symptoms, such as hiccough, vomiting, delirium, convulsions and dyspnœa. Death in coma may occur very rapidly, with ataxo-adynamic symptoms and a high or subnormal temperature.

It must not be forgotten that secondary icterus gravis may appear in typhoid and paratyphoid fevers, and that in many cases icterus merely indicates a primary localisation of the typhoid or paratyphoid bacillus in the bile passages.

A *typhoid form of infective endocarditis* has been described, characterised by shivering from the day of onset and high temperature, with pulmonary congestion, abdominal distension, diarrhœa, enlargement of the spleen, and typhoid state. The diagnosis may be difficult. The cardiac lesions, however, indicated by the presence of murmurs at the orifices, the absence of lenticular rose spots, the course of the symptoms when nothing is to be found on auscultation, and the development of emboli in various situations accompanied by shivering indicating sepsis, will be a help in diagnosis, though this can be rendered certain only by a blood-culture.

Apart from the insidious form of pneumonia which appears at different periods of typhoid fever, and is irregular in its course and symptoms (Dieulafoy), a *lobar pneumonia*, on rare occasions, may mark the onset of typhoid fever. "In the course of the first week the symptoms peculiar to pneumonia subside, and are followed by the signs of typhoid fever—swelling of the

spleen, rose spots and iliac pain" (Potain). In such cases the evolution of the disease will be a guide to a diagnosis.

Acute nephritis may have a violent onset, with pains in the loins, shivering, high temperature and scanty and dark-coloured urine.

One may think of typhoid fever, but the rapid and early appearance of the œdema, the puffiness and pallor of the face, the intensity of the albuminuria, and the frequent hæmaturia, will attract attention to the renal system.

Pyœmia, septicœmia and *puerperal fever* sometimes present a collection of symptoms which may suggest typhoid fever, such as prolonged pyrexia, distension of the abdomen, diarrhœa and typhoid state. The absence of lenticular rose spots, the oscillations of the temperature, shivering and profuse sweats which accompany these conditions, as well as the characteristic local symptoms and the circumstances in which they develop, will usually be enough to distinguish them.

Malignant hypertoxic syphilis may sometimes simulate typhoid fever so closely that Fournier has described it by the name of *syphilitic typhosis*. Numerous cases have been published (Dieulafoy, Morin, Courtaux, Vialaneix, Letulle, etc.). The typhoid phenomena usually appear during the eruption of the secondary stage. The temperature reaches 104°, the rise being accompanied by epistaxis, vomiting, headache, giddiness, prostration and adynamia. Dyspnœa and tachycardia are not uncommon. Death from collapse may occur. The diagnosis will be established by the history of syphilitic infection and a knowledge of the actual lesion, the absence of abdominal symptoms or enlargement of the spleen, the appearance of the syphilitic roseola, negative blood-culture, and Wassermann's reaction.

The practitioner is often uncertain, especially in the case of a child, as to whether his patient is suffering from *tuberculous meningitis* or typhoid fever. He is

all the more so, inasmuch as " pyrexia with remissions, headache, delirium, vomiting, cerebral maculæ, and even partial palsy, inequality of pupils, rolling the head from side to side, and the hydrocephalic cry may occur in both diseases " (Murchison).

In meningitis vomiting is more frequent, the tongue is not dry, there is no ochre-coloured diarrhœa to cause a special stain on the linen, the abdomen is contracted and not painful, the spleen is not enlarged, there is no intestinal hæmorrhage or epistaxis, the headache is more intense than in typhoid fever, and is accompanied by photophobia and tenderness of the eyeballs, and sometimes by strabismus. The trismus, cutaneous and muscular hyperæsthesia, irritability, gun-hammer position and presence of Kernig's sign will also be in favour of meningitis. Lumbar puncture and a blood-culture will decide the question.

It must not be forgotten that in the course of typhoid fever there may be actual meningitis and " meningeal states " due to the typhoid bacillus, and that the existence of enteric fever does not exclude the possibility of a concomitant meningitis of tuberculous meningococcal or other nature.

Among the other numerous diseases which may be confounded with typhoid fever, we may mention the *typhoid form of lumbricosis* (Chauffard), *acute osteomyelitis*, *appendicitis at the onset*, *cholera during the stage of reaction*, *acute glanders*, *acute trichinosis*, etc., etc.

In conclusion, we will give an account of two methods employed in the diagnosis of typhoid fever: Chantemesse's ophthalmo-reaction and Vincent's spleno-reaction.

Chantemesse's ophthalmo-reaction.—Chantemesse has proposed Calmette's method for the diagnosis of tuberculosis. A drop of water containing $\frac{1}{50}$ milligramme of a powder obtained by precipitation (with absolute alcohol) of a strong solution of soluble typhoid toxin is dropped into the patient's eye. The temperature and general condition are not affected. In persons not suffering from typhoid fever a little redness and

lacrymation are observed in two or three hours. In typhoid patients the reaction is more pronounced (redness, lacrymation and production of a sero-fibrinous exudate). The reaction reaches its maximum in from six to twelve hours, and continues till the next day. Experiments have been made with a cuti-reaction, but the results are very uncertain.

Vincent's spleno-diagnosis.—Enlargement of the spleen being the rule in typhoid fever, it occurred to Vincent that the inoculation of additional antigen (2 c.c. of a concentrated autolysat of living typhoid bacilli sterilised by ether) might result in causing a splenic reaction which would be useful for diagnostic purposes.

In healthy persons, or those suffering from other diseases than typhoid fever, no splenic reaction is observed; but in patients with genuine typhoid fever one finds, on careful percussion, an increase in size of the spleen by one or two centimetres in both diameters. This spleno-reaction is found, as a rule, ten to eighteen hours after the injection, very rarely later.

It has been observed in 94 per cent., and in 35 per cent. it is accompanied by enlargement of the liver.

Inoculation of an autolysat of paratyphoid B bacilli in patients suffering from paratyphoid fever B has produced a similar spleno-reaction.

The spleen responds to a specific irritation by an equally specific enlargement.

After injection of paratyphoid B autolysat in the course of paratyphoid fever B, increase in the size of the spleen generally appears less marked than after the injection of the typhoid autolysat in typhoid fever, though it is often very definite. Sometimes this increase in size is more marked after the second or third injection than after the first (Rathery), a circumstance due to the dose of antigen injected.

The value of the spleno-reaction is that it enables us to make a diagnosis earlier than a blood-culture, and, what is still more important, before the appearance of clinical symptoms.

II. Diagnosis by Laboratory Methods

The differential diagnosis of typhoid and paratyphoid fevers being, as we have seen, a difficult matter, it is necessary to resort to laboratory examination as soon as the existence of one of these diseases is suspected. The discovery, isolation and identification of the causal agent are usually possible if the investigation is made under favourable conditions.

Our study will be divided into two parts, the first dealing with the methods of investigating the bacillus, and the second with the humoral reactions of the organism.

Investigation of the bacillus. The typhoid bacillus is known to exist in the *blood* throughout the duration of the infection. It persists through the height of the disease, and usually disappears at the end of the third week, but it may be found in the blood even later.

After being carried into the organism by the circulation it may be localised and multiply in any organ, especially the spleen, liver, bile passages, bone marrow and mesenteric glands.

It is also found in the lenticular rose spots. It is present in the intestine several days before the appearance of the first symptoms. The number of bacilli in the fæces increases until the end of the first week, and gradually disappears at the end of the fourth.

The typhoid bacillus fairly frequently passes into the urine (Bouchard). Vincent found it in the urine in about a fifth of his typhoid cases. It sometimes persists in the fæces and urine after recovery, when the bacilli are growing in the gall bladder and bladder. According to Besson, the typhoid bacillus is found in albuminous urine exclusively. It hardly ever appears in the urine before the tenth day, and as a rule not before the fifteenth. In the urine and fæces the elimination takes place intermittently.

The typhoid bacillus has been found in the pharyngeal ulcers and in the deposit on the teeth.

Lastly, it has been isolated as the causal organism

of a large number of complications, such as tonsillitis, rhinopharyngitis, laryngo-typhoid, pleurisy, pneumonia, adenitis, abscesses, osteitis, etc., etc.

As will be seen from this list, the infective agent may be found in every possible situation. Where should the investigation be made to obtain an invariably positive result?

The bacillus can be most frequently isolated by puncture of the spleen, but this method is dangerous, as the organ can easily be torn if the patient makes a sudden movement.

Search for the bacillus in the stools is a delicate process, in which much depends upon good luck. The isolation of typhoid or paratyphoid bacilli from the stools is often difficult, owing to the large numbers of bacteria living in the intestine. This investigation, however, presents a great prophylactic and epidemiological interest, being usually employed for detecting germ-carriers and determining how long a convalescent may remain contagious. It is therefore advisable to describe the usual methods.

Plugs of mucus are sought for in the stools, washed once or twice in normal saline solution, and then planted on an appropriate medium. According to the method advocated by Sacquépée and Bellot, the large intestine is washed out twice with a litre of boiled water, it is then washed out a third time and the last part of the evacuated fluid is kept for analysis.

P. Carnot and Weill-Hallé recommend the following method: Fill one of the branches of a U tube of 5–6 millimetres in diameter with a layer of fine sand up to 10 centimetres. Pour some broth coloured with neutral red into the other branch of the tube until the broth is at the same level in the two branches a little above the sand. Then add to the broth in the second branch some drops of the almost clear fluid obtained from a second intestinal wash-out following a preliminary evacuant enema. Examine after eighteen hours' incubation. The duration of the stay in the incubator is in proportion to the height of the layer

of sand and the motility of the bacilli. The higher the level of the layer of sand, the more accurate will be the result of the examination of the micro-organisms.

The stay in the incubator may be reduced to six hours when the height of the sand is about three centimetres. The broth above the level of sand has either retained its colour but become turbid, or it has changed to a fluorescent yellow. In the first case the typhoid bacillus only, which is usually by far the most motile organism, has been able to pass through the sand and grow; in the second case the paratyphoid bacilli A and B, or the bacillus coli, have done so too. A microscopical examination is made, before and after staining by Gram's method. If bacilli are found which are not stained by Gram, they are isolated on Endo's agar or Drigalski-Conradi's medium in Petri's capsules. All the colonies stained red are disregarded. Only those colonies which are unstained, or stained a very faint pink or blue, are to be examined. Each of these will have to be identified by growth on special media, and by the examination of their agglutinability.

It is possible to isolate the bacilli from the lenticular rose spots. Chauffard and J. Troisier, by injecting subcutaneously into typhoid patients $\frac{1}{5000}$th of the dose of toxin fatal to a guinea-pig weighing 250 grammes, succeeded in reproducing a typical lenticular rose spot which is generally identical with the patient's spontaneous rose spots. This artificial rose spot may fail to appear in some typhoid patients: its duration, when it does appear, does not exceed twenty-four to forty-eight hours. In the typhoid patient it indicates the presence of an intradermic colony of micro-organisms. After washing the skin with soap, and then with alcohol, prick the spot with a needle, a small bistouri or a vaccinostyle. Aspirate with a sterile pipette the drop of blood which wells out through the little opening, and grow it in a tube of bile broth and in the water of condensation obtained from agar tubes.

By inclining these tubes the surface of the agar is moistened with the water of condensation, and the

micro-organisms are thus distributed all over the surface of the medium.

It has been said that typhoid *bacteriuria* is a late event. Its investigation is only of interest for prophylaxis and epidemiology. The clot obtained aseptically by centrifugalisation of the urine should be planted on Endo's medium.

The *pus* obtained from various sources and the *sputum* should also be grown (1) in bile broth, (2) in agar poured into Petri's capsules. The organic media in which the typhoid and paratyphoid bacilli are to be sought for during life are the blood and bile, and after death the heart blood and spleen pulp.

Culture from the bile.—Bur, Hautefeuille and Sevestre have found typhoid and paratyphoid bacilli by taking cultures from the bilious vomit which is often seen in typhoid and paratyphoid fevers. Boldyrev and Volhard have shown that the introduction of a certain quantity of oil into the stomach is followed by a reflux of bile mixed with pancreatic juice. Weber (in 1909, in two cases) and Kiralyfi (in 1912, in sixty-nine examinations of thirty cases) availed themselves of this property for the purpose of removing bile during life, cultivating it and obtaining postive results. After having washed out the stomach of a fasting patient with sterilised distilled water, 250–300 c.c. of sterilised olive oil are introduced by the same funnel. In half an hour's time the oil is withdrawn. The patient must be told not to swallow his saliva, as it will increase the number of micro-organisms in the stomach contents.

After the fluid has been collected in a sterilised recipient, it separates at once into two layers, the upper formed by the oil and the lower containing the bile. Carnot and Weill-Hallé administer only 50–150 grammes of olive oil, which they remove by gastric intubation three hours later.

In the exceptional cases where gastric mucus only is withdrawn, it should be cultivated, for the typhoid bacillus may be found in it fairly often, although less constantly than in the bile.

Carnot and Weill-Hallé also perform direct intubation of the duodenum by making the patient swallow a rubber tube of about three millimetres in diameter and one metre long, terminated by a little glass nozzle, open at the two ends, which has been carefully sterilised and is protected by the rubber tube up to its terminal orifice. The patient swallows eighty centimetres of the tube, which is left in position for three hours, sometimes four, by which time the nozzle has passed through the pylorus and penetrated into the duodenum. Aspiration is then made with a syringe fitted to the outer end of the rubber tube. If the nozzle is in the right position, almost pure bile is withdrawn.

The writers themselves admit that this technique is not always easy to carry out "in some typhoid patients in a state of prostration, who are incapable of executing intelligently the measures required."

These two processes, however, give almost the same results.

Carnot and Weill-Hallé regard cultivation of the bile as a measure possessing great prophylactic importance. In most cases it yields results later than blood-culture. It cannot be carried out before the end of the first week, but it enables us to trace a carrier long after the disease has come to an end. Thus the writers found the typhoid bacillus in the bile after the sixth month.

Blood-culture.—Very numerous methods have been employed. It would be tedious and unnecessary to describe them all. As the blood serum possesses strongly bactericidal properties, some recommend that a fairly large quantity of blood should be grown on a very large quantity of a fluid-culture medium. The blood is taken by aseptic puncture of a vein at the fold of the elbow. Ten to twenty c.c. are collected and put in a litre of beef broth, or, more economically, following H. Lemierre's example, in ordinary peptone solution prepared as follows—

Peptone	20	grammes
Sodium chloride	5	„
Water	1000	„

This process, which has been copied from Castellani and Busquet, has been employed for several years by J. Sabrazès, who prefers it to others as being the most simple, practical and certain method. Lafforgue separates the corpuscles from the plasma after adding to the blood a 2 per cent. solution of citrate of soda (1 drop per c.c. of blood), centrifugalises it and pours the clot into broth-tubes.

In the course of this war bacteriologists have endeavoured to discover the most favourable culture medium, and one which does not require elaborate apparatus.

Bile has been chiefly in favour, either in a pure state after sterilisation, or associated with beef broth, Liebig's extract, or peptone solution. The media with a bile base possess the great advantage of avoiding the coagulation of blood and of forming an excellent soil for the cultivation of typhoid and paratyphoid bacilli.

Filtered bile, diluted to a third or half of its volume by broth or peptone solution, appears best.

P. Carnot and Weill-Hallé have also employed **U** tubes with a sand filter two centimetres high for blood-culture. Into one of the branches of the tube they put the mixture of sterilised ox bile (five c.c.) and the patient's blood (twenty to thirty drops), and into the other a sterile broth. The motile bacilli growing in the bile pass through the layer of sand and multiply in the broth, where they can be much more easily examined on the following day.

Muratet, in his field laboratory, has availed himself of this process, which has been of great service to him, with the following slight modifications.

The tubes are larger than those of Carnot and Weill-Hallé. Two to three c.c. of blood are grown in one of the branches of the **U** tube containing five c.c. of ox bile and five c.c. of peptone solution. Into the other branch is poured broth coloured with neutral red (Savage's medium). When the blood-culture is positive, Savage's broth may become turbid without losing its red colour, or it assumes a fluorescent yellow colour.

P. Carnot and Weill-Hallé describe a still simpler process, which consists in making a culture of pure bile and then introducing a layer of broth above the bile-blood medium, taking care to avoid a mixture. The culture may be made in an ordinary test tube which presents a certain advantage, for the manufacture of U tubes is not always easy in the army on active service, and these tubes often break in the course of sterilisation or manipulation.

When fresh ox bile is not available, dried bile, or the "ox gall," to be obtained from a chemist's, may be dissolved in peptone solution. This method gives good results, and one can always have a small store of bile extract in the laboratory.

The substitution of bile salts for bile does not constitute a more favourable medium (Sabrazès).

Whatever the method employed, one proceeds as follows with the examination of the cultures and the identification of the organisms.

The first microscopical examination may be made with a slide and coverslip or with a hanging drop-culture, without staining, to see if the bacilli, whether motile or non-motile, have grown. In positive cases, if the bacilli are motile and are not stained by Gram, we may be dealing with one of the micro-organisms of the coli-typhoid group.

As regards these cultural reactions, generally speaking the paratyphoid A bacillus resembles the typhoid bacillus, and the paratyphoid B bacillus the bacillus coli. Paratyphoid bacilli are motile, do not stain by Gram, possess 8–10 flagella and are facultative anærobes. They cause fermentation in glucose, mannite, dulcite, lævulose, maltose and galactose, but not in lactose, raffinose or cane sugar. They differ, therefore, from the typhoid bacillus, which does not ferment any sugar. They do not coagulate milk or produce indol, which differentiates them from the bacillus coli, which ferments all sugars. One should bear in mind the existence of infections due to the *B. fæcalis alcaligenes* and the properties of this micro-organism, which, though very like the

TABLE OF THE PRINCIPAL DIFFERENCES BETWEEN THE TYPHOID BACILLUS, PARATYPHOID A BACILLUS, PARATYPHOID B BACILLUS AND BACILLUS COLI.

Diagnostic method	Typhoid bacillus	Paratyphoid A bacillus	Paratyphoid B bacillus	Bacillus coli
Odour.	No special odour.	No special odour as a rule, but sometimes a slight odour.	Disagreeable or fæcaloid odour.	Fæcaloid or fishy odour.
Motility.	Usually very motile.	Motile.	Motile.	Very variable. Usually motile, but less so than typhoid bacillus. May be non-motile.
Growth on potatoes.	Damp, faint, glistening track, then brown tint.	Damp, faint, glistening track.	Thick, shining brownish growth, sometimes scanty.	Prominent yellowish or brownish film.
Growth on artichokes.	No green coloration.	Green coloration absent or very late.	Green coloration in 2 or 3 days.	Green coloration rapid.
Growth in milk.	No change.	No change.	Becomes clear and turns brown after eighth day.	Clotting usually in 24–48 hours.
Growth in litmus milk or whey.	Slight acidity (pink tint).	Slight acidity (pink tint).	Slight acidity (pink tint) in first few hours, then alkalinisation (blue tint) from 3rd–7th day, sometimes very	Clotting of milk, red coloration in 24 hours.

Growth on lactose, raffinose or saccharose media.	Acid. No gas.	Acid. No gas.	Acid. No gas.	Acid. Production of gas.
Growth on glucose, lævulose, maltose, galactose, mannite and dulcite media.	Acid. No gas.	Acid. Production of gas.	Acid. Production of gas.	Acid. Production of gas.
Growth on glucose-neutral-red-agar.	No change.	Decoloration, fluorescence, fragmentation of the medium.	Decoloration, fluorescence, fragmentation of the medium.	Decoloration, fluorescence, fragmentation of the medium.
Growth on decolorised fuchsia-agar (Endo).	Colourless colonies.	Colourless colonies.	Colourless colonies.	Red colonies.
Growth on lactose-litmus - crystal - violet - agar (Drigalski-Conradi).	Blue transparent colonies.	Blue transparent colonies.	Blue transparent colonies.	Red opaque colonies.
Growth on subacetate of lead medium.	Blackening.	No blackening.	Blackening.	No blackening. Some exceptions.
Formation of indol.	No indol.	No indol.	No indol, or only traces.	Production of indol.

typhoid bacillus, nevertheless turns litmus milk strongly alkaline.

The identification of the organisms isolated must be completed by *a study of their agglutinability* by means of specific experimental serums. The serums employed for this purpose must be of moderate strength, 1 per 1000 to 1 per 10,000. They have sometimes a marked agglutinating property for other species (coagglutination). The largest possible number of typhoid bacilli are agglutinated in the same degree by the same experimental serum.

Some bacilli, however, which have been recently isolated from the blood, fæces or water, are not agglutinable, although they possess all the characters of the typhoid bacillus. Before regarding them as genuine typhoid bacilli, they must undergo several passages through broth. By this process the genuine typhoid bacillus progressively acquires a considerable agglutinating power.

It seems that there is some parallelism between the lack of agglutinative power and the absence of motility (C. Nicolle and Trénel). The experimental serums are specific for the typhoid and paratyphoid bacilli. They agglutinate all the strains in almost the same dilution. Exception must be made for the paratyphoid B bacilli, of which the different strains are agglutinated in very unequal dilutions.

As the experimental serums contain amboceptors, the reaction of fixation of the complement can be applied for the diagnosis.

However, if this amboceptor is specific for the typhoid bacillus, this is not the case with the paratyphoid bacilli A and B.

Experimental serums deviate the complement in the presence of the paratyphoid bacilli with which they have been obtained, but the experimental serum obtained with the paratyphoid A bacillus contains an amboceptor, which acts equally on the typhoid bacillus and the paratyphoid B bacillus.

In like manner, the experimental serum obtained

with the paratyphoid B bacillus contains an amboceptor which also acts on the typhoid bacillus (Rieux and Sacquépée).

We cannot close this chapter, which is necessarily very incomplete, without reminding our readers that in diseases resembling typhoid fever pathogenic micro-organisms, differing from the typhoid and paratyphoid bacilli by one or more characters reputed to be specific, have been isolated during life by means of blood-culture.

They may be described as "intermediate bacilli" to indicate that they belong to a group which possesses some of the characters of the typhoid and paratyphoid bacilli, without any suggestion that they represent a stage of passage from one micro-organism to the other. Cases of this kind have been published by Moutier, Faroy, Lecount and Kirby, Lafforgue, etc. A certain number of cases has also been published in which *the clinical symptoms were like those of typhoid or paratyphoid fever*, but in which *B. fæcalis alkaligenes* was isolated by blood-culture.

This micro-organism undoubtedly possesses pathogenic properties for man, giving rise to infections which are sometimes mild and sometimes remarkably severe, especially in Morocco. The symptoms, and even the character of the autopsy lesions, may resemble those of typhoid fever. The study of this micro-organism should be carefully pursued.

Lastly, there has been found in the patients' blood, in addition to the typhoid or paratyphoid bacilli, a certain number of pathogenic micro-organisms, such as the micrococcus melitensis (Bassères, Rauzier and Roger, Laggrifoul, Arnal and Roger), proteus vulgaris (Vincent), staphylococcus, streptococcus (Vincent), bacillus pyocyaneus (Vincent), hæmamœba malariæ (Kelsch and Kiener, Vincent), etc., etc.

Sometimes one of the paratyphoid bacilli, especially B, may be found at the same time as the typhoid bacillus (C. Gautier and R. J. Weissenbach).

The presence of these micro-organisms gives a special character to the typhoid infection, completely modifies

its characters, and sometimes considerably increases its gravity.

III. Study of the more or less Specific Humoral Reactions caused in the Organism by Typhoid Infections

Widal's serum test.—In a previous chapter we indicated the principle of this test. We must now discuss in detail some special points.

Normally human serum agglutinates the typhoid bacillus at 1 in 10–1 in 20, and the paratyphoid bacilli at 1 in 50, even at 1 in 150 (Sacquépée, Chevrel, Béco). In the course of typhoid or paratyphoid infections human serum acquires agglutinating properties. But these properties may be absent. They generally appear towards the end of the first week, and, on the average, acquire their maximum from the twelfth to the twentieth day. Besides the blood serum, nurse's milk (Achard and Bensaude), urine, tears, pleural fluid and cerebrospinal fluid (Brandéis and Mongour) may be endowed with agglutinating power. The mother can transmit it to the fœtus.

This agglutinating power is not absolutely specific. Side by side with agglutinins there exist group coagglutinins.

Thus the serum of patients suffering from typhoid fever may agglutinate paratyphoid A and B bacilli *as much as*, and *even more than*, the typhoid bacillus (Sacquépée). Likewise, the serum of patients suffering from paratyphoid A infection agglutinates paratyphoid A bacilli in low dilution (1 in 100 or 1 in 200), but it may agglutinate the typhoid bacillus and paratyphoid B bacillus in the same dilution. The serum of patients with paratyphoid B infection can agglutinate very energetically the patient's own bacillus (even up to 1 in 40,000), but much less other bacilli of the B type (1 in 100–1 in 1000). It is much less active, as regards the typhoid bacillus and paratyphoid A baccillus. An attempt has been made to get rid of these coagglutinins

by Castellani's process. But this test, which is accurate in the case of experimental serums, is much less reliable in the case of human serums, and its clinical value is doubtful (Rieux and Sacquépée.) To make use of the reaction it has been necessary to standardise, so to speak, the agglutinating power of the serum for the typhoid bacillus and paratyphoid bacilli A and B. Dilutions had to be pushed to extreme limits, and only strong dilutions were taken into account. Paradoxical agglutinations, nevertheless, will still be met with. Some writers, however, state that one can make a diagnosis of typhoid infection if human serum agglutinates the typhoid bacillus at a minimum dilution of 1 in 150–1 in 200, and in a much lesser degree the paratyphoid bacilli (M. Labbé, Cade and Vaucher). According to Salomon, in the presence of a negative blood-culture recourse should be made to the serum test, even in the inoculated. One may " regard as of value agglutinations for paratyphoid A and B occurring at a minimum dilution of 1 in 200, but importance should only be attached to agglutinations of the typhoid bacillus when they are definite and intense in dilutions of, or exceeding, 1 in 500."

In cases where a serum agglutinates a paratyphoid bacillus more than a typhoid bacillus, " nothing allows us at present to conclude that we are in presence of a paratyphoid infection " (Sacquépée and Chevrel). According to Rist, the specificity of the serum reaction is still less certain. " The serum reaction is of no value as a guide as to whether the typhoid bacillus or paratyphoid A or paratyphoid B bacillus is the cause of the disease. Blood-culture alone enables us to differentiate them. A positive serum agglutination in the non-inoculated fully authorises us to say ' this is a typhoid fever;' it is unable to determine which of the three micro-organisms should be incriminated."

If the diagnostic value of the serum reaction is only relative in the non-vaccinated, what is to be said of it in those who have been vaccinated ?

It is known that antityphoid vaccination causes the

appearance of powerful agglutinins in the blood serum. This agglutinating power, which may, exceptionally, be as high as 1 in 5000 or 1 in 10,000, falls fairly rapidly to 1 in 50 or 1 in 10, and even completely disappears three or four months after the last injection of vaccine. This agglutinating power may be wakened into fresh activity by any kind of disease of a non-typhoid nature (pneumonia, appendicitis, dysentery, rheumatism, ordinary sore throat, simple diarrhœa, etc.), and also by paratyphoid fever, when it rises to a considerable figure: 1 in 400 six months after antityphoid vaccination, 1 in 200 twenty-five months after vaccination with five injections, etc. (Rist, Coyon).

However that may be, at the present time millions of men have undergone typhoid and antityphoid vaccination. Owing to this fact their serum contains active or latent agglutinins for the typhoid bacillus and the paratyphoid A and B bacilli.

The results of the serum test, if performed in such cases, would be of no value for the diagnosis of typhoid and paratyphoid fevers. This is the view of Léon Bernard and Paraf: "Its results, which were already irregular and open to suspicion in subjects who had not been inoculated, are absolutely useless in those who have been; the application of this method for that purpose can only give rise to error."

This is also the opinion of Rist, who says, "In those who have been vaccinated, even with a single injection, the agglutination test ought not to be regarded as a diagnostic method. Not only does it fail to distinguish typhoid fever from paratyphoid, but it cannot even serve to discriminate an infection of the typhoid group from any febrile disease whatever. This diagnosis can only be established by a blood-culture or clinical examination."

Reservations must also be made as to the value of the clinical factor.

This is likewise the opinion of all those who have been working in army laboratories or ambulances. In the light of established facts they have had to give up their

confidence in the agglutinating serum reaction and follow the rule which H. Vincent laid down some time ago. " The blood of every inoculated person agglutinates the typhoid bacillus more or less. This agglutinating power may be aroused or exaggerated by any kind of acute infection occurring in the vaccinated. No value, therefore, should be attributed to the agglutination test as regards the diagnosis of any subsequent illness. Blood-culture alone gives precise information."

The reaction of fixation of the complement.—The blood serum of patients suffering from typhoid or paratyphoid infections contains amboceptors, which Widal and Le Sourd have detected by the ordinary method of fixation of the complement (Bordet and Gengou). These amboceptors, however, are not strictly specific (Rieux and Sacquépée). In addition to specific amboceptors there are group amboceptors, as in the case of agglutination.

It is the same with human serum as with experimental serum, and with amboceptors as with agglutinins : a real diagnostic certainty is not always obtained by investigating them.

Determination of the opsonic index.—Wright has shown that special substances are present in normal and pathological blood serum, which he has called opsonins (opsono = I prepare food for), and which are indispensable for phagocytosis.

In pathological serums the amboceptors not only sensitise and bacteriolyse the pathogenic micro-organism, but also favour the phagocytosis. The value of this power is determined fairly easily in practice, and opsonic index is the name given to the relation of the opsonic power of a pathological serum to the opsonic power of a normal serum, their power being calculated for the same bacterial species.

Milhit has shown that an opsonic index for the typhoid bacillus above 1·70 in a suspected subject is an element in favour of typhoid infection if he has not already had typhoid fever.

Rathery has recently studied the opsonic index of typhoid and paratyphoid cases which have been treated by Vincent's vaccine known as autolysat. He found that during the disease the opsonic index of these patients was fairly high. From a practical point of view Rathery thinks that it is advisable to continue vaccine treatment if a fresh injection causes a definite fall in twenty-four hours' time of the opsonic index, which rises again after the second injection.

CHAPTER V

TREATMENT OF TYPHOID FEVER AND PARATYPHOID FEVERS

A NUMBER of methods have been suggested for the treatment of typhoid fever. These methods may be grouped according to the special aim in view. We will study successively in separate sections—

1. The hygiene of the typhoid patient; the "little attentions" that he requires.
2. The diet.
3. The methods employed to lower the temperature.
4. Various measures, including antiseptics, tonics, diuretics, and methods for combating the infection.
5. Special treatment applicable to the principal complications of typhoid fever.

Lastly, by way of completing the methods of treatment indicated in the previous sections, and which are *symptomatic measures* applicable to all typhoid infections indiscriminately, we will describe the actual state of our knowledge of *the specific treatment of typhoid and paratyphoid fevers by serum therapy and vaccine therapy.*

The hygiene of the typhoid patient.—As soon as typhoid fever is suspected, treatment should be commenced at once, without waiting for clinical or laboratory confirmation.

The patient should be isolated as soon as possible in a large, well-ventilated room, into which the sun can penetrate. The mean temperature of the room should be about 60° F. Carpets, curtains and hangings should be removed. If possible, two beds should be placed in the room, so as to change the patient from one to

the other if necessary. A waterproof sheet should be put between the sheet and the mattress, and above the sheet the bed should be provided with a draw-sheet which can be easily removed and changed as soon as it is soiled or wetted. The patient should be clad in a shirt or vest which is completely open behind. Too much light should be avoided, as well as any noise, conversation or visitors. The typhoid patient needs absolute calm and repose.

The greatest attention must be paid to the patient's bodily cleanliness and antisepsis. For this purpose a whole series of precautions and methods are required comprised under the general description of "little attentions"—a rather inaccurate term, it may be said, for these attentions are of the greatest importance in the struggle with the disease.

Toilet of the mouth and nasal fossæ.—A dry, shrivelled tongue constitutes a real danger in typhoid fever because it prevents nourishment being taken. It may also be a cause of infection and dysphagia. The tongue should not present this appearance when the patient is well looked after and well nursed. From *the onset of the disease* the nurse should be set about cleaning the mouth, and under these circumstances it will be easy to keep it clean. If, on the contrary, she waits for several days, the tongue, inside of the cheeks, teeth and gums become covered with thick, hard and adherent crusts which will be all the more difficult to remove as the patient will be unwilling to submit to this fatiguing, disagreeable and sometimes even painful operation. So from the very beginning of the disease the teeth, gums and tongue should be cleaned gently several times a day with a soft brush.

For this purpose a mixture of equal parts of glycerine and eau de Vichy or eau de Vals should be used. The mouth should be washed out with one of these mineral waters or with a four per cent. solution of boric acid. The stringy mucus should be removed from the pharynx by moist swabs of wool mounted on the end of long forceps. When the cleaning is finished the patient

should be given some drops of lemon juice, as they cause a slight stimulus to the salivary secretion. In this way the excretory channels will be swept clean. If dark crusts are seen at the back of the mouth, the pharynx must be irrigated with boiled water from a can containing hydrogen peroxide, twice in the twenty-four hours at least. These irrigations prevent the development of grave infective complications (pharyngeal ulceration, quinsy, etc.), which are exclusively due to these septic accumulations of mucus.

Once or twice a day the patient may gargle or rinse out his mouth with water rendered antiseptic by the addition of a few drops of Javel extract.

By these different methods it will be easy to keep the mouth perfectly fresh and the tongue moist and clean.

After having raised some difficulty at first, the patient will afterwards ask for these attentions of his own accord.

A careful watch should be kept for the appearance of lingual, buccal or labial ulcerations. As soon as they appear they should be touched lightly with tincture of iodine, methylene blue, chlorate of potash or even formol (Milhit).

The nasal fossæ must also be cleaned, and the crusts removed, after they have been softened with a few drops of menthol oil (50 per cent.), or with menthol vaseline oil, or, better still, gomenol vaseline. Vernier recommends the insertion into the nostrils of a plug of ointment the size of a pea of the following composition—

Vaseline	20	grammes
Boric acid	2	,,
Resorcin	0·15	,,
Menthol	0·05	,,

The lips should be washed with warm boracic lotion. Attention must be paid to the ears, and the patients prevented from scratching their nose, nasal fossæ, etc.

Hygiene of the skin. The frequency of boils in convalescence from typhoid fever is well known. The

origin of these secondary infections of the skin, which may sometimes assume the character of phlegmonous inflammation and grave septicæmia, is often neglect of cutaneous asepsis.

Asepsis of the skin should be carried out in the following way. Plugs of cotton-wool containing carbolised glycerine may be placed in the ears. In addition to baths, the skin should be sponged all over with cold or warm water containing thymol, antiseptic or aromatic vinegar, or eau de Cologne. All the parts which have been soiled by the urine or fæces should also be washed by sponging rather than by rubbing the skin with damp wool. After each washing the parts should be gently dried. Every folliculitis lesion should be touched gently with iodine or iodine-acetone. As soon as the formation of a little vesicle filled with pus is observed, the pus should be evacuated aseptically and the little wound painted with iodine.

One must be on the look out for infections due to streptococci, staphylococci or B. pyocyaneus, and treat them if they appear with tincture of iodine or peroxide of hydrogen.

In some cases, when the infection is generalised, recourse should be had to antiseptic baths, preferably boracic acid (200 grammes per bath), to which has been added a little eau de Javel (liquor sodæ chlorinatæ). As prolonged pressure in association with maceration may cause trophic disturbances of the skin, especially bedsores, attention must be paid to the patient's position in bed, and he must be dried carefully after sponging or baths. He should never be left too long in the same position. Several times a day he should be made to change into a different position, such as the right or left lateral decubitus, the dorsal decubitus, or a half-sitting position, by supporting him with cushions or pillows. As ulcerations in typhoid patients have a rapid course, as soon as a redness is seen, especially in the gluteal region, after making the skin aseptic it should be dusted with subnitrate of bismuth and finely-pulverised Lucas-Championnière powder,

and care should be taken that the patient should always rest on a thick layer of heavily-powdered wool.

If the subject is fat, the natal cleft down to the anus should also be powdered after washing. If a slight ulceration appears, it should be painted with tincture of iodine and then powdered, and the region should be supported on a rubber ring. If the patient is thin, a water bed should be used.

The hair should be cut at the beginning of the disease, which can easily be done in men; as this practice has certain disadvantages in the case of women, their hair should be plaited in two or three very close plaits, which should be wetted as little as possible during the baths. In convalescence the plaits should be undone for a short time every day, for five to ten minutes at most, after oiling the scalp. The head may be washed with Panama soap and shampooed with St. Louis lotion (ammonia 4 grammes, oil of turpentine 25 grammes, camphorated alcohol 125 grammes).

Good results, especially in children, may be obtained with Comby's prescriptions.

The Lotion

Castor oil	30	grammes
Alcohol 60 per cent.	100	„
Tincture of quinine	aa	„
Tincture of rosemary	aa	„
Tincture of Jaborandi	5	„

or

The Ointment

Vaseline	30	grammes
Lanoline	10	„
Balsam of Peru	2	„
Gallic acid	1	„

To be rubbed into the scalp morning and evening.

Hygiene of the genito-urinary system.—Ulceration of the vulva is not uncommon in typhoid fever. In the case of little girls the parts should be washed carefully

every day with soap and water. In women one should order vaginal douches of a 1 in 400 permanganate solution, followed by washing the vulva with soap. In severe typhoid fever one may have to catheterise the patient. In such cases the greatest antiseptic precautions must be taken; if infection is likely to occur the bladder should be systematically washed out with 250 c.c. of a very weak hot solution of permanganate of potash.

Diet of the typhoid patient. The diet of the typhoid patient is of the utmost importance. The typhoid patient must receive nourishment, but in practice views differ as to the nature of this nourishment. Generally speaking, in France the diet prescribed is fluid or semi-fluid. It chiefly consists of milk. The patient should take a minimum of three to four litres of fluid in the twenty-four hours, two of which should consist of milk. The milk should be given only after it has been boiled for at least ten minutes. It should be kept in a cool place in closed receptacles. It may be given pure or diluted with eau de Vichy or eau de Vals, or hot, warm or cold, and with or without sugar. If the patient wishes it, there is no harm in flavouring it with small quantities of tea, coffee, rum, cognac, kirsch, orange-flower water, vanilla, essence of aniseed (one drop per cup), or in making it acid or frothy, etc. After each feed of milk it is well to wash out the mouth with eau de Vichy, ptisan, orangeade, etc. If the milk is well tolerated, the quantity may be increased to two and a half litres a day. Sometimes, although it has been boiled and had not gone sour, it may cause diarrhœa and distension. It should be given in feeds of about fifty grammes at a time, to which lime water or citrate of soda (in a dose of two grammes per litre of milk) have been added. Asses' or goats' milk may be tried. In case of absolute intolerance, recourse should be had to kefir or koumiss. Silby uses whey in amounts varying from one to three and a half litres per day, flavoured with tea or coffee. Lastly, in some cases milk will have to be given up altogether and

replaced by vegetable soup,[1] cereal decoctions,[2] or soups containing flour, and eggs and very light custards.

Besides milk, the patient may take every hour, or every half-hour, half a glassful or a glassful of such drinks as wine diluted with lemonade, weak tea or coffee, weak grog, lemonade, orangeade, fruit syrups much diluted with water, slightly alkaline mineral waters (Vichy-Célestins, Vals), and diuretic decoctions (couch-grass, cherry stalks, liquorice, etc.). The drinks may be given warm, at the room temperature, or even iced. They should not be made too sweet, as an excess of sugar may increase intestinal fermentation. Lactose, which is diuretic, may be used, in a dose of 100–200 grammes per diem, to sweeten the drinks.

The patient should drink often, but little at a time, and very slowly.

Apart from exceptions based on the general state, appearance of the tongue and the temperature, he should not be woken up for a drink, but all suitable occasions should be made use of. The best times, and those when he will be most ready for a drink, are after

[1] Vegetable soups are much used in the treatment of children's diseases. Among the numerous prescriptions, Méry's formula is to be recommended.

Potatoes	60 grammes
Carrots	45 „
Turnips	15 „
Dried peas	6 „
Dried beans	6 „
Cold water	1 litre
Salt	5 grammes

Boil for two hours; filter; make the filtrate up to a litre by adding cold boiled water. Add 5 grammes of salt.

[2]

Barley Pearl barley Pounded maize Shelled beans Shelled peas Shelled lentils	30 grammes or a ladleful of each

Boil for three hours in a litre of water, add 5 grammes of salt and strain.

the cleaning of the mouth, and during and after the bath at the moment of reaction.

Milk and drinks are not always sufficient nourishment for typhoid patients.

Robin adds a litre of veal or chicken broth in the twenty-four hours.

It rarely happens in the course of typhoid fever of moderate intensity that one can make the patient take all the nourishment he needs. As a rule he takes much less. Sometimes, even, he refuses all nourishment. One is forced to feed him by a tube, or, which is much less desirable, carefully give him nutrient enemata containing milk and peptone and the yolk of an egg. The patient's refusal to take food is hardly ever persistent; in a few days' time he usually consents to take any kind of nourishment.

The regime which we described should be continued till the time when the temperature has definitely fallen and keeps below 98·6°. As soon as the general condition improves and the temperature falls to about 98·6°, the patient begins to have a craving for food. The doctor must make the convalescent understand that a too hasty return to substantial food exposes him to a relapse, which may be grave, and even fatal. The patient's attendants and family should be warned of all the dangers that may be caused by indulging the convalescent's immoderate appetite even in a slight degree.

As a general rule, while the temperature fluctuates between 98·6 and 99·6° he may take three litres of milk or broth. He may also be given a light, well-cooked tapioca pudding.

If the temperature keeps at about 98·6°, one may gradually try a little more substantial diet, for very often inanition in emaciated and debilitated subjects is enough to maintain a slight rise of temperature, which disappears as soon as the patient takes a little more nourishment. But in most cases one must wait till the temperature has been normal for three or four days. Then, very cautiously, keeping an eye on the tempera-

ture and the stools, one may give a little well-cooked tapioca or semolina in some meat or chicken broth, with the daily addition of the yolks of one or two eggs. If the temperature does not rise the patient may take two soups of a somewhat thicker consistency, and then *purées*. Lastly, he may be allowed a small piece of stale bread, without crust, in the soup, with a boiled egg and jam, and then successively a little fresh fish, chicken, beef or mutton, with the order to eat it slowly and masticate it well. If the fever reappears, he should return immediately to milk and broth. If the patient does not have a stool daily, his bowels should be moved by prunes, stewed fruit, or an enema of cold water.

Such is the diet which almost all French physicians have ordered their patients. Other scales of diet have been advocated.

Johnson and Watt do not give milk until convalescence. Their patients' diet is composed of soup made of barley meal, rice, oats, eggs and sugar. They use large quantities of gelatin.

This diet cannot escape criticism. In addition to its nutritive properties, milk has also diuretic properties which the most nutritious broth does not possess. Gelatin may combat and even prevent diarrhœa and hæmorrhage, but it is not nutritious, and, even by flavouring it, it is difficult to mask its disagreeable taste and make the patient take fifty grammes of it daily for several weeks.

A certain number of Russian authors (Gournitzki, Botkine, Puritz, etc.) and Vaquez, in France, with the object of preventing excessive emaciation and shortening the duration of convalescence, give substantial nourishment to their patients.

They maintain that the temperature is not increased, the risks of perforation and hæmorrhage not greater, nor relapses more frequent in consequence of their method. Although he does not, like the Russian authors, go so far as to give his typhoid patients soup, rissoles, cutlets and potatoes, Vaquez's diet is nevertheless a very generous one. Every two hours the patient

has a cup of milk, but at 8 a.m., noon and 6 p.m. a small meal may be substituted for this cup of milk. At 8 a.m., a cup of tea or coffee and milk, or a plate of farinaceous soup (raccahout, barley or rice); at noon, bread and milk with a yolk of an egg, a wineglassful of meat jelly or cold meat juice; at 6 p.m., the same meal but with some broth with an egg beaten up substituted for the bread and milk. In the night a similar little meal with milk. The principal meals are given on leaving the bath. When the temperature falls, grated raw meat, such as mutton or pork, is given. Then various soups, rice pudding and potatoes, until on the eighth day of convalescence the patient is given biscuits, boiled eggs, etc.

This method has been criticised. In any case, it is not suitable for severe attacks.

Claisse gives a small meal every four hours to his typhoid patients who cannot digest milk. Farinaceous foods and sugar predominate in his diet scale; potato *purées*, light soups, semolina cakes, fruit jellies and fruit juice, with cocoa and butter. He does not give milk till convalescence, when he also gives eggs, and then meat. He adds after some time to his diet cultures of the paralactic bacillus.

Thomson, in cases in which the temperature is not high, suppresses the milk or reduces it considerably, adding meat juice, lactose, white of egg, and light broths. In the first days of apyrexia, if the patient has no diarrhœa or distension, and has not had hæmorrhage recently, his diet-scale consists of pastry, sweets, lightly-cooked eggs, rice, milk, biscuits, mutton or chicken broth, meat jellies and farinaceous soups. The doctor can modify the diet according to the indications furnished by each particular case. He should only remember that the diet of the typhoid patient must be at once substantial and perfectly assimilable, that all the digestive secretions are deficient in these patients, and that one must not force upon them a diet which cannot be easily digested; that it should not contain any solid particle which is capable of

mechanically irritating the intestine; and that, finally, it should not be distasteful to the patient, who has already too great a tendency not to take enough nourishment.

Antipyretic Measures

One of the first indications in typhoid fever is to lower the temperature. This result may be obtained by external applications or internal treatment.

External applications comprise a certain number of hydro-therapeutic measures, such as *affusions*, *wet packs*, *sponging*, *baths*, applications of ice, compresses and enemata.

Sponging.—Sponging, which was introduced by Jaccoud, can easily be employed at any time or place, and may be sufficient in the treatment of slight or moderate attacks. According to O. Martin, intestinal hæmorrhage, myocarditis, or a tendency to collapse should contra-indicate its use, but Milhit, on the contrary, says that sponging is indicated in all syncopal or hæmorrhagic forms. Pulmonary complications are not a contra-indication. They may be given with cold (53·6–59° F.) or warm water. The duration of the sponging must not exceed three minutes; the colder the water the shorter it must be. The patient lying at full length naked on the bed, a large sponge is rapidly passed all over his body, soaked with water which is either plain or, better still, contains eau de Cologne or aromatic vinegar. The patient is then rolled in a blanket and given a hot alcoholic drink. He is left thus for fifteen to twenty minutes, and then wiped without touching the abdomen. Two to ten or twelve spongings may be given in this way as a substitute for baths.

Although its action on the temperature is very slight, sponging is nevertheless extremely useful owing to the sense of comfort which it induces as a result of the sedative influence on the nervous symptoms and the stimulating action on the prostration.

Affusions.—Affusions are an old-standing practice,

having been introduced by Currie and employed in France by Récamier, Chomel, Trousseau, Guéneau de Mussy, etc. Contra-indications to their use are the same as in sponging, or even stronger. Besides, patients do not support them well. Baths are to be preferred if a fall of the temperature is desirable. "The patient is placed in a bath, and two persons in rapid succession pour cold water of 50–59° F. on his head and back for some minutes; if a douche is available, its duration should be very short, and not exceed one to two minutes" (Guéneau de Mussy). The fall of temperature obtained is on an average 0·9–1·0° F.

Wet Packs.—Wet packs, consisting of a moistened sheet, are to be recommended chiefly for children. They calm restless patients and make them sleep. Their technique is simple. A sheet is plunged into cold water, wrung out vigorously and spread on a blanket. The patient is placed naked on the sheet and wrapped up completely in it. He is left thus for about a minute, then wiped and put back to bed. This method of reducing the temperature is a rather brutal one. It causes a shock to the typhoid patient and provokes intense distress, and sometimes even syncope.

Treatment by baths.—Balneotherapy is the treatment of choice in typhoid fever. Not only does it cause a remarkable fall in temperature, but by its remote effects especially it possesses a very real and efficacious therapeutical action. The most certain and best studied of these effects are: improvement in the pulse and arterial tension, which indicate improvement in the cardiac tone; calming of the nervous symptoms; increase in diuresis and the intestinal secretions; diminution of the dryness of the mouth and stimulation of respiratory oxidation.

Brand's method.—Currie (1787) introduced this method, which Brand (1861) appropriated and codified, and Glénard (of Lyons) introduced into France. Brand's complete method consists in giving the patient, night and day every three hours, a cold bath for a quarter of an hour at 64·4° F. if the rectal temperature

is above 102·2° F. To attenuate the disagreeable impression caused by the first bath, it may be given at 71·6° F. The following baths are each lowered by 1·8° F., so that the fifth would be at the desired temperature of 64·4° F. (Brand, Juhel-Renoy).

Cold affusions are given by pouring water at 50° F. on the nape of the neck from just above the head for two minutes each time.

Tripier and Bouveret recommend continuous affusion.

As soon as the patient enters the bath he is given a drink of brandy or wine. About ten minutes after the commencement of the bath he is seized with intense shivering. This is the signal for the bath to end. He is given another drink of brandy or wine and placed at full length on the bed, on which has been previously laid a blanket covered with a warm dry sheet. He is then wiped quickly and gently without touching the abdomen, wrapped up in a blanket, with a hot bottle at his feet, and left to *shiver*. In a quarter of an hour or half an hour's time general relief is experienced. The patient feels better, and after he has been clad and given a drink he usually goes to sleep.

In severe hyperpyretic and adynamic fevers in which the heart, kidneys and lungs are severely affected, the advocates of Brand's method employ a special technique until improvement sets in, called the *intensive method*, of which Juhel-Renoy gives the following description. A first bath is given at 78·8°, a second at 75·2°, and so on, diminishing each bath by 3·6° F., so that by the eighth bath the regulation temperature of 64·4° F. is reached. The duration of the bath will be shorter: eight to ten minutes. Shivering is to be *obtained* and *prolonged* by lowering the temperature of the bath to 59·0°. Cold affusions (46·4–50° F.) should be carried on throughout the duration of the baths, with massage and friction of the limbs under water. Large thoracic and abdominal compresses are absolutely necessary. If the patient shows the least sign of getting worse he should be put in a bath again every two hours instead of every three hours, and if the heart

shows signs of weakness, an ice-bag should be placed on the præcordial region.

Such is Brand's method, which involves no form of treatment besides the baths. According to its advocates, its only contra-indications are profuse intestinal hæmorrhage and perforation.

A method of this kind rigorously carried out is not suitable for all patients, and especially for women and children, or nervous and impressionable patients, or for soldiers coming from the trenches exhausted both by the infection and overwork. In a hospital where the best installation and nursing were available, it yielded a mortality of 19·5 per cent. (Petges, Dumora and Peyri). Whatever may be its advantages, in ordinary cases equally good results may be obtained by milder methods which are less disagreeable to the patient.

Warm or tepid baths (89·6–82·4° F.), which constitute a mild form of Brand's method, regulate the temperature curve in the same way.

Nervous and excitable patients, as well as children, support them better than cold baths and derive more marked benefit therefrom. These baths may be of short duration—ten minutes, for example, with or without cold affusions on the nape of the neck at the end of the bath (Grasset)—or be prolonged even for a whole day (Riess).

Warm baths gradually chilled.—In the chilled bath the advantages of the cold bath are retained without those properties which are unnecessary or disagreeable to the patient. This method was introduced by Bouchard, who uses a bath whose temperature is 3·6° F. below that of the patient. By adding cold water the bath is gradually refrigerated by 1·8° F. every ten minutes. When the water is at 86° F., the chilling is stopped, and the patient is taken out of the bath. The higher the temperature of the patient, the longer these baths may be continued. They are repeated six to eight times in the twenty-four hours. Carrieu reduces the duration of the bath to a maximum of an hour, starting with a temperature of 98·6°, and chilling

it sometimes more rapidly by adding cold water every five minutes until it reaches 86·0°.

He gives five or six baths on the average; often less, rarely more, being guided by the initial temperature for the day. If three hours after a bath the patient's temperature has not fallen by 1·8° below his initial temperature, he gives another bath; but if it has, he waits an hour or more.

In some forms of typhoid fever, with hyperpyrexia and nervous phenomena, cold baths, which should be repeated as often as is necessary, still constitute the real treatment. It is most important not to delay, and to employ them *from the beginning of the disease*, regulating the number of the baths by the patient's temperature.

Hot baths.—Bosc advocates hot baths at 102·2° F., and from twelve to fifteen minutes in duration. They gave him good results in the treatment of cholera, as well as in severe broncho-pneumonia and bronchitis. According to him, these warm baths have an eliminatory, sedative, revulsive and antiphlogistic action, as well as a regenerative effect upon the myocardium. Bosc recommends them for children who violently object to cold baths, and for cases with grave respiratory complications, anuria or diminution of the urinary secretion, severe delirium, or when the heart is much affected. In the adult "the two most formal indications—*i.e.* those in which no other method can be permitted—are (*a*) in cases where the cold bath is contra-indicated owing to the state of the heart; (*b*) in the case of the hæmorrhagic form of typhoid fever, and especially in hæmorrhagic nephritis with headache, nausea and vomiting, suggesting an uræmic complication" (O. Martin).

Whatever the mode of bath treatment adopted, there are certain rules which must always be followed. *The patient should not make any effort.* He should be carefully carried from his bed to the bath, which should be near at hand, in the same room. He should never, in any case, go there by himself, owing to the

risk of intestinal perforation, syncope or sudden death. The water in the bath should be changed very often, at each bath if possible, or at least once in the twenty-four hours. The patient's buttocks should be slightly vaselined before the bath. Grave infective complications may sometimes originate from baths given with water contaminated by fæces, and the water should have a mild antiseptic put in it (boracic acid, cresyl, naphtholate of soda, liquor sodæ chlorinatæ).

Advantage should be taken of the bath to clean the patient's mouth and give him a warm drink systematically. The typhoid patient should never be left alone, even for a minute, during the bath. In some cases the doctor should give the bath himself, and carefully watch the pulse meanwhile.

On leaving the bath, the patient should never be rubbed down or wiped dry. He should be put on his bed wrapped up in a blanket, and the reaction should be waited for. The beginning of the phase of reaction is an indication for giving him another drink. If this phase is too prolonged or is unsatisfactory, the patient should be warmed by hot drinks, and given coffee, and the following bath must be shorter and hotter.

There is an absolute contra-indication if intestinal perforation or commencing peritonitis is suspected. If there is considerable intestinal hæmorrhage which is repeated, the baths should be stopped for a few days and then resumed, a careful watch being kept upon the patient, or cold sponging should be substituted.

Baths should also be discontinued if phlebitis occurs. The appearance of a cardiac complication requires the presence of the doctor during the bath, so as to guard against a possible fainting attack.

With these exceptions, baths have no other serious contra-indications; they should not be prevented by pulmonary congestion, bronchitis or menstruation.

Compresses.—Brand borrowed from Jacquez (of Lure) the method of *cold water compresses*, which are placed on the abdomen, thorax, head and even the whole body, and frequently changed. Cheinisse recom-

mends the direct application to the abdomen of a compress soaked in 90 per cent. alcohol and wrung out. The compress is covered with a layer of wool soaked in cold water, on which is placed a piece of mackintosh, and the whole is kept in position by a flannel bandage. The water compress is changed every hour, and the alcohol compress every two hours.

Enemata.—In 1875, Foltz (of Lyons) proposed the administration, every three or four hours, of a litre of cold water of a temperature of 50–59° F. *per rectum.* Nowadays large injections or enteroclysis are preferred, consisting of three to four litres at a low pressure by the use of a sufficiently long tube. Two enemata of boiled water are given daily at a temperature of 64·4–68° F. if preferred cold, or at 104–107·6° F. if hot. Hot enemata appear to be more diuretic than cold, though the latter, on the other hand, bring down the temperature more. Whether cold or hot, they clear the intestine of débris and putrid products, allow the absorption of fluids, and may serve as a vehicle for antiseptics which will disinfect the lower part of the intestine. Thus to the boiled water can be added boracic acid, phenosalyl, in doses of 5 grammes per litre, or liquor sodæ chlorinatæ, in doses of 10 grammes per litre.

Drop by drop method.—The intra-rectal instillation of a solution of glucose or cane sugar in a strength of 50 or 60 per 1000, drop by drop, gives excellent results, rapidly causes the headache and general discomfort to disappear, and at the same time increases the urinary secretion (P. Emile Weill, F. Rathery, J. Carles, etc.). It should be given hot (122° F.) and very slowly. Three hours at least are needed for the instillation of a litre of fluid. Under these conditions only can the patient keep and absorb the fluid. If necessary, adrenalin or chloral can be added to the sugar solution.

Refrigeration by cold air.—J. Sabrazès has had recourse to refrigeration of the typhoid patient by cold air, thus reviving the simple, practical and efficacious method of James Sims (1778).

Internal medication.—Generally speaking, *as few drugs as possible* should be given in typhoid fever. They fatigue and irritate the stomach, sometimes provoke vomiting, and, with the exception of special and definite cases, are of little service (Lemoine and Gérard, Dieulafoy). As regards the antipyretic drugs which have been recommended, we will say a few words about those most commonly employed.

Cryogenine should be used only when the urine is abundant. Apart from its antipyretic action, it is analgesic, and causes the headache to disappear entirely. The dose for an adult is 0·30 gramme. It is well to know that it colours the urine yellow, and that some typhoid patients suffer from severe hypothermia, with collapse, even after 10 centigrammes of the drug.

Pyramidon, even in very small doses and combined with caffeine, may cause profuse greenish vomiting, with pronounced contraction of the abdomen and a fall of temperature to 98·2°, suggesting perforation (Hirtz); it may also produce severe symptoms of collapse (Rist, Brault).

Antipyrine, whether combined or not with bicarbonate of soda, has an injurious action both on the heart and kidneys; it diminishes the elimination of toxic products. These two drugs, therefore, should not be generally employed.

Quinine should not be used for lowering the temperature. It has no antipyretic action in the course of the disease. It may be employed as a tonic (Robin, Lemoine and Gérard). It is best to reserve it for those cases in which the history or examination of the blood shows that the patient is the subject of malaria. Marfan has advocated it on account of its stimulating action on the heart, especially in children: the hydrochlorate of quinine is the preparation chiefly used, in doses of 0·05 gramme to 0·10 gramme for each year of age, in the twenty-four hours, and in doses of 0·50 to 1 gramme in adults.

Various Modes of Treatment

Bleeding.—Bleeding, of which so much abuse was made in former times, may serve as one of the agents for combating infection (Pecker, Grasset, O. Martin). It may be employed in the severe forms in which the patient presents marked signs of intoxication; such as a very pronounced typhoid state, or in the ataxo-adynamic form; likewise in cases in which the patient has a severe attack with a feeble reaction and comparatively low temperature.

Lastly, it will be prudent to bleed if other methods for removing toxins are not sufficiently rapid; when the heart-sounds become more and more muffled and the pulse weak, soft and irregular with a high number of beats, 150, 200 or 300 grammes of blood may be withdrawn, but an injection of *artificial serum* should be made at the same time. The solution employed will be the so-called normal saline solution of sodium chloride at 7 per 1000 (Dastre, Mayet, Delbet, Bosc and Vedel). Dieulafoy adds 0·10 gramme of benzoate of caffeine per litre of serum to 9·5 per 1000 of sodium chloride, and injects from 50 to 400 grammes. The injection may be made into the muscle, but if it is made after the bleeding, or if rapid effect is desired (*e. g.* in a case of alarming collapse), it should be made intravenously and very slowly. Injections of normal saline raise the blood pressure, stimulate the nervous and hæmatopoietic centres, and facilitate the elimination of toxins by provoking abundant diuresis, frequent diarrhœa and sometimes vomiting.

Fixation abscess.—This old method of treatment, which has been employed with varying success for the treatment of septicæmia, consists in the injection of 1 c.c. of oil of turpentine beneath the skin of the thigh on its outer aspect. It is said to cause a decided fall in the temperature and improvement of the patient's general condition if it results in the formation of an abscess (Rathery). When the injection does not cause an abscess, the prognosis as a rule is gloomy. J. Carles

usually keeps this method for septicæmic forms with severe and protracted broncho-pneumonia, and for those occasions in which a serious inflammatory or purulent localisation may be expected owing to the organ affected.

Antiseptic medication.—For the digestive disturbance which is so pronounced a feature at the onset of typhoid fever, hydrochloric lemonade may be of service in doses of 2–4 grammes per litre.

Purgatives and laxatives should not be employed either in the adult or child, except in the course of the first week. At the onset a saline purgative may be given, *e. g.* 15–20 grammes of sodium sulphate or magnesia: calomel, whose action on the liver is well known, may be given, especially to children. Dieulafoy employs manna in doses of 15–25 grammes in milk.

After the first week every purgative or laxative should be avoided, as they are capable of producing just those complications which we endeavour to avoid, viz. hæmorrhage, perforation and peritonitis. If their employment does not always have such grave results, it may cause rises of temperature. Courtellemont has fairly often seen death from perforation, especially from the twelfth to the twentieth day, after the administration of a purgative. The following course of events is not uncommon: the taking of a laxative or purgative, two days afterwards hæmorrhage, and two or three days later perforation and death.

Among other drugs employed, the most usual are *beta-naphthol*, in doses of 2·50 grammes in the twenty-four hours (Bouchard); *betol* (salicylate of naphthol); *benzonaphthol*, 3–4 grammes in 6 or 8 doses suspended in milk; *salol*, associated or not with *salicylate of bismuth* (Dujardin-Beaumetz); *lactic acid* in the form of lemonade in doses of 15–25 grammes daily (Hayem); *peroxide of magnesium* in keratinised capsules of 0·30 gramme, two capsules to be taken every three or four hours (Kirkpatrick); *camphorated phenol* in doses of ten drops every two hours; *urotropine* (Chauffard, Triboulet and Lévy), which, it must not be forgotten, may

cause hæmaturia in acute infectious diseases, and especially in typhoid fever (Karkowski), but, by reason of its elimination by the bile passages, causes a biliary and genito-urinary antisepsis simultaneously. *Iodine*, as the freshly prepared tincture, has been employed by Raymond, Arnozan and Carles.

Diuretics.—We have already insisted on the necessity of making the typhoid patient drink a large quantity of fluid, so as to provoke diuresis, and elimination of all the toxins by the renal channel.

Injections of normal saline favour diuresis. It is the same with *cold sponging*, *baths* and *hot enemata*. These different methods will suffice in most cases. It may, however, be necessary to prescribe *lactose*, *theobromine*, *digitalis* and *adrenalin*, which have a diuretic action, but also respond to other indications.

Tonics.—Alcohol in all its forms (wine, rum, cognac, liqueurs) is a good tonic. English physicians give doses of alcohol which we regard as excessive, sometimes more than a litre in the twenty-four hours. In France an average of 80–100 grammes of alcohol is given. Frequent use is made of wine, chiefly champagne, which the patients tolerate and drink readily, especially when it is iced.

Caffeine and *ether* respond to special indications, which we will discuss later.

Drugs for combating infection.—The direct employment of colloidal substances has been proposed, *e. g. collargol*, electrargol, lantol (colloidal rhodium), colloidal gold (Letulle). Their action in some cases has appeared beneficial, but their value is by no means proved. Robin, who has paid special attention to the study of electrargol and collargol, concludes that they are inefficacious in the treatment of typhoid fever.

Treatment of Complications

In the course of typhoid fever certain normal symptoms may become exaggerated and constitute an aggravation, such as diarrhœa when it becomes pro-

fuse and does not yield to treatment. But these are mere incidents. The real complications are "intestinal hæmorrhage and perforation, pulmonary congestion and pneumonia, myocarditis and weakness of the heart, nephritis, and every result of the lesions, degenerations and infections peculiar to typhoid fever of a severe character or which has come under treatment late" (Merklen). These accidents and complications involve special indications for treatment, which we will briefly describe.

Complications Involving the Digestive System

Diarrhœa.—Too active measures should not be taken against the diarrhœa. To check it, it will be sufficient to give sterilised milk diluted with lime water, or to lengthen the interval between the feeds.—Lemonade with *lactic acid* (10 grammes) with syrup of rhatany or lemon, benzo-naphthol, *salicylate or subnitrate of bismuth*, absorptive powders such as prepared chalk and charcoal, or *dermatol* (subgallate of bismuth) may be prescribed.

Constipation.—Avoid laxatives and purgatives after the first week. Have recourse to *intestinal lavage* or enemata. A daily enema of boiled water, which may be given cold (when it does not cause colic) or warm, is usually sufficient. Emollient enemata (mallow, or marsh mallow root) have been recommended. Oil or glycerine may be added to the water. When the constipation is obstinate, and accompanied by abdominal pain and meteorism, calomel (10–25 centigrammes) should be given.

Vomiting.—This may sometimes be due to too large a consumption of alcoholic beverages, and their diminution or suppression will be enough to stop the vomiting. Iced or aerated drinks, and cold compresses or ice on the epigastrium will also produce a good result. Hydrochloric lemonade (2–4 grammes per 1000), *Rivière's potion*, *ether* sprays, inhalations of *oxygen* and *menthol*

(in three or four doses of 5 centigrammes at long intervals) will give good results. Vomiting is fairly frequently a symptom of suprarenal insufficiency, as is proved by the efficacy of treatment by adrenalin (Khoury).

Intestinal hæmorrhage. — Absolute rest should be ordered. The baths must be stopped; the patient should be placed in the dorsal decubitus with an ice-bag on the abdomen; drinks should be iced and in very small quantities, consisting of champagne, iced lemonade with eau de Rabel, or a draught containing water 130 grammes, syrup of rhatany 30 grammes, eau de Rabel 2 grammes (Dieulafoy), to be given in spoonfuls.

Every twenty-four hours the patient should be given 3–4 grammes of calcium chloride, with or without large hot enemata (Mathieu).

If the hæmorrhage is profuse and obstinate, all food by mouth should be absolutely stopped, and an injection of *normal saline* (600 c.c.–1800 c.c.) should be given at a temperature of 102·2 or 104° F.

Injection of gelatinised serum has given good results. The hæmorrhage may be so profuse that the patient faints. In that case the head should be placed as low as possible, an injection of ergotinin should be given, and then as soon as possible an injection of horse serum or normal saline solution. The patient should be made warm. Injections of *camphorated oil* and *ether* are sometimes of service.

Intestinal perforation. Peritonitis. — "Every undoubted perforation of the intestine demands surgical intervention" (Michaux). This intervention should be done as soon as possible. While waiting for the surgeon, the patient should be kept absolutely still in bed, all fluid should be stopped. An intramuscular injection of nucleinate of soda should be given (Miculicz, Chantemesse, Tuffier), which has the property of causing a leucocytosis which increases the patient's resistance. If necessary, injections of ether, camphorated oil or caffeine should be given.

The physician's rôle is limited to this. Surgical intervention alone can save the patient.

Cardiac complications.—In moderate attacks the strength of the heart is, as a rule, sufficiently maintained by the diet, meat juice, etc., containing alcohol and wine. In more severe attacks ice should be put on the præcordial region, the baths should be given hotter and with extreme care, at longer intervals or stopped altogether. Repeated injections should be given of camphorated oil, ether, sparteine, sulphate of strychnine, and normal saline solution containing adrenalin. Lastly, since the rôle of the suprarenals has been better understood, numerous accidents due to suprarenal insufficiency have been reported (E. Sergent, Hutinel). The patient is given adrenalin subcutaneously, either in the form of $\frac{1}{4}$–$\frac{1}{2}$ c.c. of a 1 in 1000 solution, or, better still, as adrenalin in a saline solution obtained by adding 1 c.c. of 1 in 1000 solution of adrenalin (*i. e.* 1 milligramme of adrenalin) to 250–500 c.c. of normal saline solution (Josué).

The total extract of the suprarenals taken internally in daily doses of 0·20 to 0·40, with or without injection of normal saline solution with adrenalin, glucose or novocain, is very successful in the severest cases with threatening collapse, or at the time of convalescence (Rathery, Josué, Sabrazès).

In some cases faradisation of the heart has been employed with success, the positive electrode being placed on the pneumo-gastric and the cathode over the heart.

Pulmonary complications.—Pulmonary complications are far from being a contra-indication for baths. At most they may sometimes have to be given a little hotter. It is most important for the typhoid patient to change frequently his position in bed. This change will prevent or restrict any pulmonary complications. If they do occur, *dry or wet cupping* will be the best treatment. Blisters should never be applied.

In cases of diffuse bronchitis or broncho-pneumonia, injections of emetine hydrochloride for four consecutive

days, in doses of 4, 6, 7 or 8 centigrammes, have given the most excellent results.

Serous or hæmorrhagic pleurisy is generally absorbed and very rarely requires thoracocentesis. As for *purulent pleurisy*, if thoracocentesis is not sufficient, it may be necessary to perform thoracotomy. If the laryngeal symptoms do not yield to moist, hot compresses or inhalations, in severe cases with suffocative attacks it will be necessary to resort to tracheotomy.

Nervous complications.—Hot or cold baths exercise a remarkably sedative action on most nervous symptoms. These may, however, by their intensity and obstinacy, require special treatment.

Headache is usually diminished or removed by affusions, or cold or iced compresses, but sometimes proves more obstinate. Lumbar puncture not only permits of examination of the fluid withdrawn, but causes almost immediate relief. A single puncture is often sufficient.

Urinary complications.—When the patient passes little urine, dry cups should be placed over the kidneys. But the best diuretics are always the cold bath, milk and lactose. Diuretic drugs have generally little effect. If the patient has retention, he must be catheterised, with the aseptic precautions described above.

In cases of bacteriuria the bladder should be washed out with a weak solution of permanganate of potash.

Cutaneous complications.—In dealing with the nursing of the typhoid patient we have laid special stress on the skin lesions, which can be prevented by asepsis. If a *bedsore* develops, in spite of all the precautions taken, it should be disinfected carefully and closely watched, for it may be the starting-point of secondary septicæmia.

In addition to the measures indicated above, we may use dressings of salol, aristol, dermatol or Vincent's antiseptic powder (boracic powder 100 grammes, fresh hypochlorite of calcium 10 grammes).

Abscesses and *phlegmons*, especially in the *parotid*, should be incised without delay.

Specific Treatment

Serum therapy. Vaccine therapy.—A successful specific treatment for typhoid and paratyphoid fevers has long been sought for. Two methods have been proposed: *Serum therapy* and *Vaccine therapy.*

Serum therapy.—Chantemesse has employed a serum derived from horses which have undergone a long immunisation. These horses were given *soluble typhoid toxin* exclusively. At present, injections of this toxin are sometimes given and sometimes intravenous injections of living bacilli, according to the method of Rodet and Lagriffoul.

Soluble toxin is obtained by cultivating very virulent typhoid bacilli on a special medium containing defibrinated blood and spleen and bone-marrow broth (Chantemesse). In a week's time the culture is heated to + 55° C., centrifugalised and decanted.

The most active serum is obtained after the last injection given to the horse. But the activity of this serum varies.

At first Chantemesse injected the patient with 5–15 c.c. of his serum, but later he injected extremely small doses, consisting of only a few drops.

According to Milhit, the serum stimulates the organs producing *opsonins*, the secretion of which becomes very intense. At the same time a high leucocytosis appears (as much as 18,000 white cells per cubic millimetre), with polymorphonucleosis and eosinophilia (Balthazard).

According to Chantemesse, the worse the patient is, the smaller should be the doses of serum injected. He particularly advises that cold bath treatment should not be neglected, but continued with the serum treatment. From statistics published by him and by Josias and Brunon, it appears that the mortality in cases treated by this method has been 4·3 per cent.

A large number of serums has been prepared by injecting animals with filtered cultures (Shaw, Meyer, Bergell, Aronson, Richardson, etc.), or extracts of

bacilli ground in liquid air (Macfadyen). Besredka inoculated an animal first with dead and then with living bacilli. Jez has used the blood-forming organs (bone-marrow, spleen, thymus), in a crushed and filtered state, from animals which had been strongly immunised against the typhoid bacillus. H. Vincent prepared a typhoid serum by injecting a horse with very virulent and highly toxic cultures of strains of bacilli cultivated in a collodion bag within the peritoneum of a guinea-pig.

Rodet and Lagriffoul inject living cultures of bacilli into the veins of sheep and horses. According to them, the most active serums are derived from animals who have received only a small number of injections and minimal doses. Serums derived from animals who have been given too large and numerous doses have an injurious effect, and even show an action which favours the experimental toxi-infection. Rodet thinks that the treatment by this serum should only be undertaken when typhoid fever has been diagnosed by a blood-culture or serum test, without any previous or superadded infection. Myocarditis and intestinal hæmorrhage form absolute contra-indications. The serum should be given subcutaneously, at an early date, *i. e.* at the latest at the tenth to the eleventh day of the febrile period; 15–20 c.c. are given at one or two injections, with an interval of two days.

According to Rodet, in thirty-six to forty-eight hours a fall of temperature, improvement of the general condition, and, in spite of the high temperature, a marked sense of well-being are to be observed. In patients who have not had the bath treatment there is a veritable polyuria, which precedes apyrexia by several days. In several cases the disease is shortened. The writer recognises that "the result depends on the quality of the serum, for it is difficult to make the horses produce a serum whose value is constant."

Vaccine therapy or *bacterial therapy*.—For the first time, in 1892, Frænkel treated fifty-seven patients by injecting them with cultures of typhoid bacilli which

had been heated to 63° C. (in doses of 0·5 c.c.–2 c.c). He had five deaths, or a mortality of 8·7 per cent.

Since then numerous authors have employed vaccine treatment by various methods, in England (A. E. Wright), in the United States (Petrovitch), in Italy, etc.

The vaccine used for this treatment may be divided into three classes—

1. Vaccines of living bacilli.
2. Vaccines of bacilli killed by heat.
3. Vaccines of bacilli killed by ether: Vincent's bacillary vaccine and autolysat.

1. *Vaccines of living bacilli. Living sensitised vaccine* (Besredka).—This vaccine, when given in four injections in increasing doses, one every three days (in doses of from one to four thousand millions), produces locally pruritus, more or less marked erythema, with decided rise of temperature and improvement of the general condition in twenty-four to forty-eight hours, with marked diuresis and sometimes actual polyuria. Some days later there is a progressive fall of the temperature. Ardin-Deltheil, Nègre and Raynaud have employed it in thirty-seven cases in patients who were having the ordinary general treatment. They had no deaths, and only two of their patients had relapses.

Sablé thinks that Besredka's vaccine has in some cases produced an undoubted action on the temperature and general condition. Deléarde and Leborgne, who have employed it in the typhoid fever of children, do not think that the old methods of treatment should be given up at present, *e. g.* cold baths, ice to the præcordial regions and plenty of fluids.

Faucher and Lafosse have had rather bad results with this vaccine in military patients.

2. *Bacilli killed by heat.*—Josué and Belloir have made use of autovaccines, *i. e.* vaccines obtained from cultures of bacilli derived from the patient himself and heated to 56° C. for six hours. They give three injections of 200,000,000 bacilli at twelve hours' interval. They say that they have obtained good results, without any complications.

The other vaccines in use are mostly hetero-vaccines.

Among these is the *bacillary vaccine* sterilised by heating at 56° C., used in England, the United States, etc., as well as in France. The vaccine to be employed contains, on the average, 100,000,000 bacilli per c.c.

The injection is made in the deltoid region. At the onset of the disease, in severe cases, small doses must be given. The first injection is thirty, forty, or fifty million bacilli; the second, given five days later, is half the first, and the third and fourth, given at the same intervals, are only ten millions.

The temperature curve descends regularly by lysis after treatment. D'Oelnitz, in children, obtained similar results, with leucocytosis and definite increase in the size of the spleen. Castaigne has published a series of charts showing rises of temperature after each injection of vaccine. These rises were followed by a pronounced fall the next day.

Generally speaking, heated bacillary vaccines employed in large doses have a violent action, which cannot be measured or foreseen. The reaction of the temperature in an upward or downward direction is often very marked. A certain number of writers are guarded as to their use, as it may be accompanied by shivering, collapse, icterus and even rupture of the spleen. But such accidents are the result of too large doses.

In order to avoid subcutaneous injections, Courmont and Rochaix have suggested giving patients two rectal injections daily until convalescence, containing 100 c.c. of a culture of typhoid bacilli killed at + 53° C.

3. *Polyvalent bacillary vaccine sterilised by ether. Autolysat.*—H. Vincent has shown that the preventive vaccine tends to check the disease if it is given at the onset of the incubation period, when the exact moment at which the ingestion of typhoid bacilli took place can be determined (laboratory cases). It has also been found that individuals vaccinated during the incubation period have had mild, abortive or shortened attacks of typhoid fever.

Generally speaking, considerable prudence is required in the employment of vaccine therapy, the object of which is to rouse and stimulate the latent defensive forces of the infected organism and to provoke the secretion of an excess of antibodies (amboceptor, bacteriolysis, etc.).

The indications and contra-indications for vaccine treatment by the ether vaccine may be resumed as follows—

1. A patient with a severe attack, and especially one of long-standing, should not be given vaccine treatment. He cannot undergo with impunity the shock necessarily induced by the inoculation of an additional quantity of antigen. It is, therefore, at the beginning or in the first two weeks of the disease—when the patient still possesses a store of defensive energy and is not too deeply intoxicated—that vaccine treatment can be employed to best advantage.

2. Too high doses of antigen may be dangerous. It is evidently just the same with anti-typhoid vaccine as with any very active drug. But, on the other hand, too small doses, whether repeated or not, remain without effect.

Experience has shown that extracts or autolysats of living bacilli, afterwards sterilised by ether, produce in the adult very superior results to those given by the bacillary vaccine properly so-called. The latter, on the other hand, has yielded remarkable results in the child (E. Weill).

Bacillary vaccines and specific autolysats sterilised by ether are prepared for typhoid fever, and for paratyphoid A and B fevers.

Before undertaking vaccine treatment one should make sure of the diagnosis by an early cultivation of the blood. In the absence of a blood-culture, investigation of the spleno-reaction, carried out with the autolysat (it is very inconstant with the bacillary vaccine), may help to settle the diagnosis.

The first dose of antigen to be injected in an adult is 1 c.c.

The inoculation is made subcutaneously in the clavicular region (and not behind, as in preventive inoculation), because the patient is in bed. The injection should be made preferably in the morning. If the vaccine causes an abnormal rise of temperature or pain, 0·50 gramme of aspirin should be given an hour after injection, except in cases of intolerance or special contra-indication.

If the temperature does not fall thirty-six or forty-eight hours later in an appreciable degree, the injection may be repeated, when the spleen, which had become enlarged, has returned to its former size. This reduction in size usually occurs two or three days later. The dose on the second occasion is 1–2 c.c. However, if a fall of temperature occurs, one must avoid disturbing this salutary defervescence by a fresh injection of vaccine. Such an injection would result in arresting the decline of the fever, and in causing a sort of negative phase by neutralisation of the already existing amboceptors. Another injection should only be made when the temperature has returned to its former level, or nearly so.

Very marked enlargement of the spleen constitutes a contra-indication for the use of vaccine treatment (Vincent).

In patients treated by vaccine therapy there is no need to modify or suspend the cold bath treatment.

The injection of vaccine causes, or may cause, a diminution of the toxi-infective symptoms, and, two or three days later, a fall of the patient's temperature. Convalescence may occur in two, three or four days. Unfortunately, this improvement in the symptoms is *by no means constant.*

Relapses seem rarer than in patients who have not been treated by vaccine.

Variot, Grenet and Dumont have treated sixteen patients with Vincent's polyvalent vaccine. Only one died, and he had been injected at the time of a perforation. Four times defervescence was obtained in twelve days. In one patient, in the course of a severe

relapse with meningeal symptoms and infective erythemata, the temperature fell in forty-eight hours after an injection of 1 c.c. of vaccine. In the other case the duration was shortened, the general state improved, and the pulse rate lessened.

In thirty-four out of fifty cases treated by Thiroloix the disease was made milder and shorter.

E. Weill treated fourteen children by the preventive bacillary vaccine, sterilised by ether. These cases of typhoid fever, which were of moderate intensity, first came under treatment from the third to the tenth day.

Weill injected children above five years of age daily with $\frac{1}{4}$ c.c., $\frac{1}{2}$ c.c. and 1 c.c.; then, after missing one day, with 1·5 c.c. and 2 c.c. Below that age he began with $\frac{1}{8}$ c.c., to end with 1 c.c. or 1·5 c.c.

Recovery was obtained in one or two weeks, in one case only in twenty days. There was no death, no relapse and no complication.

Lenglet treated his paratyphoid A cases with vaccine therapy. Although it did not always reduce the duration of the height of the disease, the vaccine seemed to prevent any relapse. Doubtless for the same therapeutical reason complications were exceptional.

Rathery and Michel treated with Vincent's autolysat para. B 147 cases of paratyphoid fever B, in which the diagnosis was confirmed by laboratory examination. They had only five deaths, or a mortality of 3·40 per cent. They regard vaccine therapy as a useful adjunct to treatment, a very definite improvement of the general state having followed the injections almost invariably. In a fairly large number of cases the disease seems curtailed, and the symptoms of a hurried crisis occur (fall of temperature, polyuria, etc.).

In some subjects vaccine therapy seems to produce no perceptible effect, but even in these cases it seems that the method of treatment does not fail to exercise a beneficial influence on the course of the disease.

P. Emile Weill has treated some cases of obstinate typhoid osteomyelitis by injections of H. Vincent's ether vaccine, with excellent results.

The treatment consists in two injections weekly until recovery: the doses of the first injections are respectively $\frac{1}{4}$ c.c., $\frac{1}{2}$ c.c., $\frac{3}{4}$ c.c. and then 1 c.c., which dose is then continued without further increase. When employed in this sort of preventive manner, vaccine therapy will yield remarkable results, considering the slowness with which the typhoid bone lesions form.

In osteomyelitis of paratyphoid origin, Weil thinks it would be advisable to employ the same method, using paratyphoid bacilli.

SECOND PART

EPIDEMIOLOGY AND PROPHYLAXIS OF TYPHOID FEVER AND PARATYPHOID FEVERS

CHAPTER I

EPIDEMIOLOGY OF TYPHOID FEVER—FREQUENCY OF THE DISEASE

THE historical and geographical study of the epidemic or endemic manifestations of typhoid fever bears witness to the extent and gravity of this important disease. No country is protected from its attacks. It is prevalent in villages as in large towns, in armies in time of peace and still more so in time of war, when it causes a considerable number of deaths.

In France, in the course of twenty or twenty-five years, typhoid fever carries off a number of inhabitants equal to that of a large town such as Toulouse. From 1906 to 1910 (both inclusive) *The Sanitary Statistics of France*, published by the French Home Office, registered 22,463 deaths due to this infectious disease. During the same period of four years Paris alone had 1251 deaths from typhoid fever.

From 1891–1900 the average proportion of deaths from typhoid fever per 100,000 inhabitants in some of the towns of France has been as follows—

Havre	115	Rheims	30
Rouen	61	Lyons	24
Marseilles	56	Bordeaux	24
Nantes	45	Paris	21
Toulouse	32	Lille	11

The deaths from typhoid fever in France from 1913 to 1915 inclusive, in towns of 30,000 inhabitants and more, have been as follows—

1886–1890	0·54 per thousand
1891–1895	0·34 „
1896–1900	0·30 „
1901–1905	0·20 „
1906–1910	0·18 „
1911	0·18 „
1912	0·13 „
1913	0·14 „

From 1896–1900 the typhoid mortality in the principal European countries reached the following figures per 100,000 inhabitants—

Italy	49·7	Sweden	15
Hungary	34·4	Denmark	11·1
France	27·6	Germany	10·3
Belgium	25·8	Netherlands	10·2
Austria	24·6	Switzerland	8·4
Ireland	20·7	Norway	7·5
England	17·5		

More recently, the comparative mortality from typhoid fever in various European countries per 100,000 inhabitants has been as follows—

Years	France	Germany	England	Belgium	Spain	Italy	Switzerland	Netherlands
1906	14	5	9	12	47	28	4	
1907	15	4	6	11	41	25	5	
1908	12	5	7	11	34	27	3	6
1909	10	4	6	9	27	28	3	5
1910	8					26	4	
1911						27·5		
1912						22		

Spain, Russia, Italy, France, Belgium and Roumania are among the countries which suffer most from typhoid fever.

The etiological conditions which cause the outbreak of the disease are indeed common to the soldier and

the civilian. The special susceptibility of the soldier certainly helps to explain the remarkable frequency with which he is affected.

The following table shows the respective percentages of cases due to this disease in the principal *armies* in time of peace.

TYPHOID FEVER IN VARIOUS ARMIES

Incidence per 1000 *men*

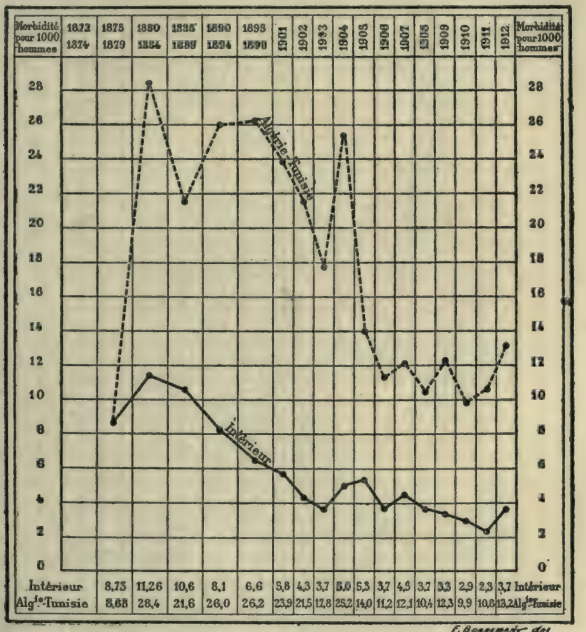
Armies	1903	1904	1905	1906	1907	Average for the 5 Years
French . . .	5·10	5·30	3·70	4·53	3·74	4·49
German . . .	0·95	0·79	0·77	0·51	0·41	0·68
English . . .	0·80	0·80	0·60	0·60	0·70	0·70
Austrian . . .	1·60	1·60	2·10	2·0	3·10	1·88
Bavarian . . .	0·47	0·22	0·93	0·11	0·17	0·38
Belgian . . .	1·89	3·10	1·35	0·82	0·86	1·60
Spanish . . .	2·60	4·82	3·68	4·72	2·87	3·73
Italian . . .						4·92 [1]
Roumanian . .	4·80	4·08	6·90	5·33	3·57	4·73
Russian . . .	5·30	3·80	5·10	5·60	5·50	5·06
United States .	5·14	4·77	3·39	6·15	3·87	4·66

It is important to note that the incidence and mortality of typhoid fever in the French army are diminishing appreciably and, one may say, every year, thanks to the careful hygienic measures adopted. The institution of antityphoid vaccination began to reduce the incidence of this disease commencing with the year 1913. It is found, however, that in the distribution of cases throughout the country, there is a regular predominance of typhoid fever in the army corps in the south and south-west of France, viz. the XVth at Marseilles, the XVIth at Montpellier, and the XVIIth at Toulouse, as well as among the troops stationed in the west of France, *e. g.* Xth Corps (Rennes), XIth Corps (Nantes).[2]

[1] From 1900–1903 (both inclusive).

[2] In the French army, Algeria and Tunis, by their high incidence of typhoid fever, raise the general percentage incidence.

In these same regions the civil population also pays a high toll to the same disease, as Brouardel had observed long ago. Owing to the close parallelism existing between the diseases of the civil population and those of the army, Spain, Roumania, Italy, France,



Russia, the United States, etc., are among the nations whose civil population, like their army, shows the highest typhoid mortality.

Typhoid Fever in War Time

No conditions predispose so much as war to the outbreak of typhoid fever and paratyphoid diseases. Marston,

a Medical Officer of the American army, has rightly called typhoid fever "the greatest scourge of armies in time of war." Thanks, however, to the hygienic

measures adopted, modern wars are far from showing the appalling incidence of the wars of bygone times.

The War of Secession (*June* 1, 1861–*June* 30, 1866) put in the field 431,237 men, who showed 75,368 cases of typhoid fever, or 175 cases per 1000, and 27,056

deaths, or 57·78 deaths per 1000. Out of 1000 deaths due to all causes, 209 were caused by typhoid fever. Even these figures do not include the cases of typho-malarial fever, *i.e.* the association of typhoid fever and malaria.

During the *Franco-German War* of 1870, the German army, whose effectives were 815,000 men, had 73,396 cases (80·3 per 1000), and 6965 deaths due to typhoid fever.

The *Turco-Russian War* of 1877–1878 furnished another proof of the intensity of typhoid infection among troops in the field.

The Russian army of the Danube, comprising 529,000 men, had 25,000 cases of typhoid fever (not including the cases of " undetermined typhoid diseases "), or 42 cases per 1000, with 7800 deaths, or 12 deaths per 1000, whereas this army lost in battle only 4955 men.

The army of the Caucasus, which suffered most, had 24,473 cases, or 99 per 1000, and 8900 deaths, or 36 deaths per 1000, as compared with only 1975 who were killed by the enemy.

We have here an example of the extreme gravity of typhoid fever as well as of its frequency in the combatant soldier. Of 100 typhoid cases, 36 succumbed.

During the campaign in *Bosnia-Herzegovina*, out of 2085 deaths due to various diseases, 944 were caused by typhoid fever.

The *Tunis Expedition* in 1881, and the *South Oran Expedition* in the same year, offered numerous examples of the extreme gravity of typhoid. The army of 20,000 men sent to Tunis had 4200 cases (one case among five men) and 1039 deaths (more than one death in twenty). The Innocenti Column (21,000 men) sent into South Oran had 1400 cases of typhoid fever and 425 deaths.

The small French Column which took part in the Allies' Expedition to China had 633 cases and 100 deaths.

In the *War with Spain* the American troops, con-

sisting of a force of 107,937 men, suffered severely from typhoid fever. The average proportion of cases was 192 per 1000. There were nearly 3000 deaths.

The first division of the first corps, with a force of 11,339 men, during its stay at Chickamauga Camp, and after leaving the Camp, yielded a total of 1921 cases.

The second division of the same corps (11,357 men) had 2172 cases.

The third division, which suffered most, out of a force of 10,329 men, had 2726 cases, a proportion of 263·91 cases per 1000, or more than *one case in every four men*, with a mortality of 16·36 per 1000.

To sum up. The first, second and third divisions of the First Corps, out of a force of 33,025 men, had 6819 men in hospital for typhoid fever, with 471 deaths due to this cause.

In the *Transvaal War* typhoid fever (enteric fever) was far and away the predominant disease in the English army, of which the average strength was 265,000 men.

Out of 22,450 deaths from disease, typhoid fever caused 7991.

The number of men killed by the enemy was hardly greater—8590. During the Siege of Ladysmith the average number of deaths from typhoid fever was sometimes 10 per day.

In the *German Expedition* against the Herreros there were 1277 cases and 140 deaths. In the period 1905–1907, out of a force of 18,116 men there were 3146 cases of typhoid fever (Kutscher).

The *Russo-Japanese War* offers a happy exception to the observations made in other wars.

The explanation of this will be given later. The Russian army had 21,309 cases, and the Japanese army only 5474 cases of typhoid fever. The disease rapidly increased after August 1904, and reached its maximum in November.

We may remark that the collection of statistics given above really includes under the same heading para-

typhoid fever, the nosological isolation of which is of more recent date.

The War of 1914–1916 has furnished a new proof of the great importance of typhoid fever in armies on active service. During the first months of this war, although the season was remarkably favourable for the outbreak of typhoid fever, in spite, also, of the terrible fatigue to which our soldiers were subjected, typhoid fever proved to be extremely rare. This remarkable result must be attributed to the fact that these young troops, who were made up of contingents coming from the interior, Algeria, Tunis and Morocco, were in very great part immunised by vaccination.

Strategic necessities, as well as the losses sustained in the open field and in the trenches, brought, in successive batches, into the war zone large quantities of fresh troops who were composed, especially at first, of men whom it had been impossible to immunise.

The general mortality of the French Army at the front dropped almost at once, and kept at a very low level as soon as rigorous measures were taken.

It cannot be doubted that if typhoid fever has shown itself very fatal in past wars, it would have been destined to play a preponderant rôle in the pathology of present or future wars if prophylactic measures, and especially vaccination, had not been applied energetically, continuously and conscientiously.

CHAPTER II

ETIOLOGY OF TYPHOID FEVER

Favouring Causes

Typhoid fever is due to a special bacillus which, after penetrating into the organism, is disseminated in the blood and then settles in the lymphoid organs, Peyer's patches, spleen, bone-marrow, liver and gall-bladder, and nervous system. It gives rise to a *toxi-infection*, the symptoms of which have been described in the first part of this work.

This bacillus is therefore the necessary condition for the development of typhoid fever.

Its mere absorption, however, is not always sufficient to enable it to multiply and give rise to the characteristic disease. In large epidemics the members of an affected community do not all contract typhoid fever, though they are all exposed to the same cause of infection. Some have such mild forms of the infection that it passes unnoticed, even by the patient. Others, and they form the largest number, escape the disease.

In like manner the inhabitants of the same town who have drunk the same contaminated water, the soldiers living in the same barracks and exposed to the same risk of contagion, are not all attacked by typhoid fever. What is the explanation of this?

It is well known that many pathogenic agents, in order to grow in a healthy subject, under ordinary conditions, require a certain number of adjuvant circumstances called *favouring causes*.

Repeated observations have illustrated this special

influence of favouring causes in the etiology of tuberculosis, cerebro-spinal meningitis, pneumonia, etc. There are, indeed, few diseases in which these causes play so important a part as in typhoid fever.

Among these causes there are some which may be called extrinsic, *i. e.* independent of the individual, such as the influence of heat, seasons, etc. Others, on the contrary, are inherent in the individual, one of the best known being that of age.

In practice it is necessary to become familiar with these causes, for if we are powerless to escape from some of them, we should be alive to their favouring action and take measures to check the threatening infection by a still more rigorous prophylaxis.

The rôle of *seasons* in the evolution of typhoid fever has long been known. Although it may appear at all seasons of the year, typhoid fever is specially frequent in the warm season and in the autumn.

The observations of Murchison in England, and of Marc d'Espine, Besnier and Kelsch in France, have shown the predominance of typhoid fever in the æstivo-autumnal period. In towns where the disease is endemic, it is almost always in summer that epidemic recrudescences are observed. It goes without saying that there is no absolute rule in this respect. Some epidemics have occurred in winter, like the epidemic at Cherbourg which broke out suddenly on January 25, 1909, or the epidemic at Tours which began in January and February 1914. The epidemic which began in November and December of 1914, during the great war, may also be quoted.

Generally speaking, however, epidemic cases usually occur in the months of July and August, involving a considerable number of the inhabitants of a village or town, and frequently lasting until November.

The army offers every year, in time of peace, a very remarkable example of this epidemic rhythm. The curve of all the cases and most of the deaths are at their lowest level during the winter season. They rise, sometimes suddenly, on the appearance of the warm

season and keep more or less at this level during this period. The influence—an indirect one, it need hardly be said—of the external temperature on the annual course of epidemics is shown by the fact that in Algiers and Tunis, where the hot season occurs earlier, the rise of the epidemic curve takes place a month sooner than in France; it also lasts a month later.

The disease is also much more frequent in that part of the world.

As we have said, the towns in the South (Marseilles, Toulon, Avignon, Castres, Beziers, Narbonne, Montpellier, Toulouse, etc.) are among those in which the civil population, no less than the military, pays the highest toll to typhoid fever.

There is, therefore, an etiological factor which confers a cyclical character on the incidence of typhoid fever, viz. heat. All the countries on the shores of the Mediterranean, as well as hot and sub-tropical countries, are dangerous foci of typhoid fever. The early history of the occupation of Morocco was marked by a very severe typhoid mortality, which involved the colonists and first immigrants.

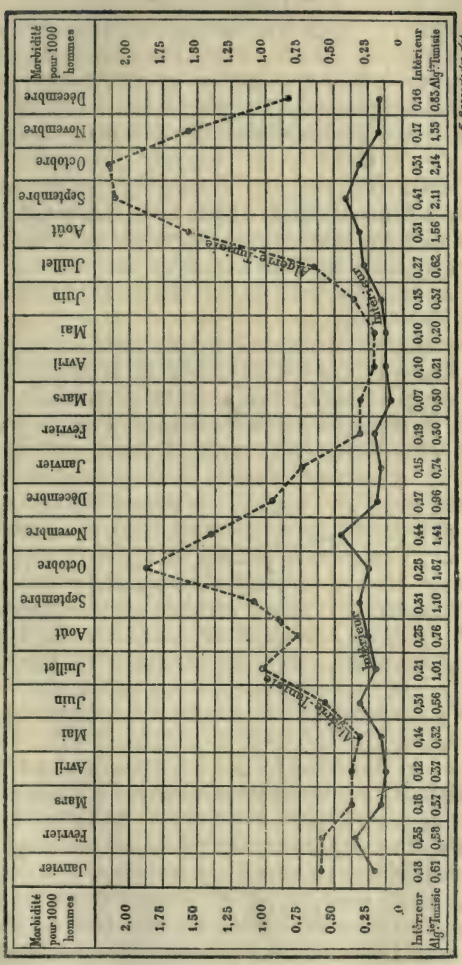
These insanitary conditions, resembling those which marked the occupation of Algeria and Tunis, have to-day been entirely removed—in the army at least.

In the French and Belgian Congo the colonists, manufacturers, explorers, trading companies and companies for developing railways, have supplied typhoid fever with numerous victims.[1]

The disease remains frequent for the same reason in Egypt, India, Eritræa, Central America, the Philippines, etc.

All infectious diseases with an intestinal localisation, such as dysentery, cholera, infantile and ordinary diarrhœa, show an epidemic fastigium which coincides with the high temperature and hot weather.

[1] The influence of heat is shown not only by the number of cases of typhoid fever, but also by their gravity, to which it adds considerably. The severity of the symptoms and percentage mortality are much greater in warm countries.


Morbidité pour 1000 hommes
2,00
1,75
1,50
1,25
1,00
0,75
0,50
0,25
0
Janvier
Février
Mars
Avril
Mai
Juin
Juillet
Août
Septembre
Octobre
Novembre
Décembre
Janvier
Février
Mars
Avril
Mai
Juin
Juillet
Août
Septembre
Octobre
Novembre
Décembre
Intérieur 0,13 0,35 0,18 0,12 0,44 0,51 0,21 0,25 0,51 0,25 0,44 0,17 0,15 0,19 0,07 0,10 0,10 0,35 0,27 0,31 0,41 0,51 0,17 0,16
Alg.ie Tunisie 0,61 0,58 0,57 0,37 0,32 0,56 1,01 0,76 1,10 1,67 1,41 0,96 0,74 0,30 0,50 0,21 0,20 0,37 0,82 1,56 2,11 2,44 1,33 0,85
Intérieur
Algérie - Tunisie

In addition to these æstivo-autumnal variations of enteric fever, multi-annual variations have been noted (Besnier), *i.e.* recrudescences of epidemics every five, six or seven years. They are due to the arrival in the same infected locality or town of new and susceptible subjects. The proportion of susceptible individuals is also increased by a certain number of births.

In an estimation of the favouring causes inherent in the man himself, and which act either as a check or as an aggravation of the typhoid infection, much importance must be attributed to the influence of a *previous attack*, as well as to that of age, race and overwork.

The immunity conferred by a previous attack of typhoid fever is very great, but it is not, however, absolute or permanent for a certain number of individuals. It may be calculated that 1 to 2 per cent. of those who have had typhoid fever are liable to contract it a second time. The second attack is usually milder. The interval between the two attacks is from two years (very exceptional) to seven years and more. The second attack of typhoid fever fairly often occurs after a journey abroad, where the subject is contaminated by other strains of the bacillus, as has been seen in colonists or travellers to Morocco. Similar observations have been made in the case of malaria.

There seems to be a familial predisposition for typhoid fever.

It is not uncommon to see an abnormal number of cases of this disease among members of certain families, living under different conditions and in different areas. On the other hand, there is no doubt that certain individuals or races are immune.

As we have seen, typhoid fever is an ubiquitous disease. All races are liable to it. During the War of Secession the coloured troops, though they were less affected than the others, nevertheless had 192·14 cases per 1000 and 57·71 deaths per 1000. In the

Eritræan Campaign the native troops and porters suffered, though in a less proportion, from the same disease.

The Germanic race is as liable to typhoid infection as the Latin. Not only was typhoid fever frequent in the ranks of the German army in 1870–71 and in the present war, but the German prisoners sent to Morocco showed, shortly after their arrival, some epidemic cases, which were immediately checked and arrested by preventive vaccination.

The Japanese race has little susceptibility, as was proved by the rarity of attacks in the Japanese army during the Manchurian War, in which the number of cases was four times less than in the Russian army. The same was found to be the case on the occasion of the Expedition to China in 1901 (Shimosa).

Is this relative immunity the result of previous attacks in childhood among the Japanese, or is it the result of the very rigorous prophylaxis adopted by the Japanese troops? It is impossible to say. The same question, namely, the influence of racial immunity, is suggested by the Arabian and Hindoo races. In spite of very bad hygienic conditions, the Indians rarely suffer from typhoid fever. It is the same with the Herreros. A comparison of the incidence of typhoid fever in Algeria among the Arab troops with that among the French troops living in the same garrison towns has shown that the former had 80 to 100 fewer cases of typhoid fever than the latter (H. Vincent). As a matter of fact, the Arabs in Algeria include men of Aryan race (Kabyles), who are very susceptible. On the other hand, the transfer of Arab soldiers to Morocco has revealed the frequency and gravity of typhoid fever among them. There is, therefore, some reason to think that those who have not been attacked possess an acquired immunity, the result of typhoid fever contracted in childhood, rather than a spontaneous or racial immunity.

A similar reason may be given to explain, on the one hand, the lesser frequency of typhoid fever in

inhabitants of large towns, and, on the other hand, the high susceptibility of country people who have been uprooted and transplanted into towns. The emigration of rural populations into towns exposes them, among other dangers, to attacks of infectious disease, and especially typhoid fever. Servants of both sexes and employees from the country who take up situations in towns in which the sanitary conditions are defective and the drinking water is contaminated, are before long attacked by the typhoid bacillus, especially if they are young. The same observation was made long ago in armies, even during the War of Secession.

Typhoid fever may be observed at all ages. A pregnant woman, when attacked by this disease, may communicate it to her fœtus, as has been shown by numerous examples.

Typhoid fever may also attack old men of eighty years and over. But all epidemiologists have noted the exceptional frequency of the disease during adolescence, and especially in young men or women, single or married. The largest number of cases usually occurs about the twenty-first year.[1] Brouardel, in an analysis of 10,036 deaths from typhoid fever, found that 3896, or *more than a quarter* of the deaths, occurred between the ages of twenty and twenty-five.

J. Bertillon says : " The frequency of typhoid fever is considerable after the second year of life ; then it rises until twenty to twenty-five years of age, *when it reaches its maximum.*"

The male sex is much more frequently affected than the female, with the exception of the first years of life.

The increase in the incidence of typhoid fever from twenty to twenty-four years of age specially applies to the male sex : at this age there are fewer cases of

[1] According to Murchison, out of 100 cases of typhoid fever, 46·5 are observed from fifteen to twenty-five years ; the average age at which typhoid fever is most frequently contracted is twenty-one years.

typhoid fever in the female sex than between fifteen and nineteen years of age.

From 1876–1905 the average annual mortality from typhoid fever in Paris among 100,000 inhabitants was as follows—

From 0 to 1 year	9·2
„ 1 „ 4 years	50·9
„ 5 „ 9 „	51·3
„ 10 „ 14 „	62·0
„ 15 „ 19 „	95·7
„ 20 „ 24 „	94·0 [1]
„ 25 „ 29 „	53·8
„ 30 „ 34 „	35·0
„ 35 „ 39 „	25·4
„ 40 „ 44 „	17·9
„ 45 „ 49 „	16·7
„ 50 „ 54 „	12·3
„ 55 „ 59 „	10·4
„ 60 „ 64 „	8·7
„ 65 „ 69 „	8·0
„ 70 „ 74 „	5·7
„ 75 „ 79 „	6·0
Over 80 „	7·1

These figures, which have been taken from J. Bertillon's statistics, show that the curve of typhoid fever is fairly low in the first year of life, rises suddenly from one to four years—that is to say, from the time when the child changes his milk diet for one approximating to that of an adult—keeps at about the same level up to fourteen years of age, then shows a new rise, this time a maximal one, between fifteen and twenty-four years. *Young persons of the male sex are most frequently attacked between the ages of twenty and twenty-four.* The frequency of typhoid fever remains high up to thirty, and then progressively falls, a phenomenon which is perhaps explained not only by the diminished susceptibility of advanced life, but also by the immunity resulting from a former attack.

[1] From 1886–1905 the average death-rate at this age was 104·7 per 100,000 inhabitants. The *male sex* had 67·1 deaths, the *female sex* 37·6.

The previous observations, on which Prof. Brouardel often insisted, furnish the explanation of the predilection which typhoid fever has always had for the *army*. Brouardel has dwelt on the principal reason for this. "Statistics," he says, "show that among 10,000 soldiers living in France from 1875–1901 there were 11·2 deaths from typhoid fever, whereas a similar group of 100,000 civilians loses only 3·8." This difference can easily be explained.

"In the population of towns, individuals from fifteen to twenty-five represent almost one-sixth of the total population. Now it is in this sixth part in which is to be found 46·5 per cent. of the cases of typhoid fever, *i.e.* half of the deaths from the disease. This amounts to saying that one-sixth of the civil population furnishes half the deaths from typhoid fever.

"If the civil population is divided by six, and the typhoid deaths by two, and if the proportion per 10,000 inhabitants be worked out, it will be found that the group of fifteen to twenty-five years yields a mortality of 11·5 per 10,000 civilians, while that of the army is 11·2." [1]

For many other reasons, also, a close comparison cannot be made between the morbidity of the civil population of towns and that of the army, which is in great part composed of very susceptible inhabitants from the country. Furthermore, a condition peculiar to the army, without any analogy in the civil population, is constituted by the regular arrival, every three years before the law of March 21, 1905, and every two years since that date, of soldiers who formed part of the army in time of peace. Epidemic diseases are thus supplied with fresh life at frequent intervals, and chances of infection in a military environment are considerably multiplied.

Moreover, in the army soldiers who have only had

[1] This incidence of typhoid fever in the French army has considerably declined. In the years 1909, 1910, 1911, it was 4·7, 3·1 and 4·6 respectively per 10,000.

one year of service always show a higher incidence of typhoid fever than old soldiers.

The same peculiarity has been noted in foreign armies. Thus in the English army in India, in 1899, the soldiers under twenty had 18·8 cases of typhoid fever per 10,000.

The soldiers aged from				20–25	had	31·3	cases	per	1000.
,,	,,	,,	,,	25–30	,,	11·5	,,	,,	,,
,,	,,	,,	,,	30–35	,,	5·8	,,	,,	,,

Of all the favouring causes which predispose most to typhoid infection, none is more powerful than *fatigue and overwork*. The influence of these two factors is united in war, especially in those which are violent and prolonged, like the present war.

There is, indeed, no condition which involves such an expenditure of moral and physical energy as war.

Acute overwork may of itself cause death, as is seen in the case of trained animals, such as carrier pigeons. Fatigue and absence of sleep cause a veritable auto-intoxication. The urine and blood, which reveal the saturation of the organism by waste products, are three to four times more toxic than normally. For this reason, after excessive fatigue, and at the moment of recovery, an extraordinary output of urea may be observed (even up to 126 grammes in twenty-four hours, according to Revilliod).

The clinical experiments of Charrin and Roger showed long ago the predisposing rôle of fatigue in infections. The same factor diminishes the principal protective element in the serum, viz. alexine (H. Vincent). It is easy to understand why individuals who have been deprived of part of their means of defence are less successful in resisting infections, and especially such frequent infectious diseases as typhoid and paratyphoid fevers.

Typhoid fever is pre-eminently the disease of the overworked, and, consequently, of war. We have already seen the excessive frequency of this disease. The war in Manchuria was alone an exception to this

law. The favourable sanitary state of the Russian and Japanese armies is explained not only by the hygienic measures adopted by the belligerents, but also because fatigue was almost unknown by the soldiers. The war was characterised by very long intervals of rest, interrupted by a few violent battles.

No condition, therefore, predisposes so strongly to typhoid fever as war, especially war during the æstivo-autumnal season, because the depressing action of heat is added to that of excessive fatigue. During the Tunis Expedition every prolonged march was followed by a recrudescence of typhoid fever.

CHAPTER III

ETIOLOGY OF TYPHOID FEVER—THE HUMAN FACTOR—ITS DETERMINING CAUSES

We studied in the last chapter the principal conditions favouring the outbreak of infection due to the typhoid bacillus. By themselves alone they are obviously unable to give rise to the disease.

They arouse the infection, but do not create it.

Further, the disease may quite well develop in a perfectly healthy subject and in the absence of these predisposing factors. It is none the less true that they are often at work either to help on the infection or to exaggerate it.

The typhoid bacillus is the chief cause of the infection. Its most constant portal of entry is the alimentary canal.

After penetrating into the organism by the stomach, the bacillus is or may be rapidly absorbed by the small intestine, especially when it is swallowed in a fasting condition, with impure water, for example, or at the beginning of a meal with such food as oysters.

The very frequent existence of tonsillitis or sore throat at the onset of typhoid fever, which is seen in 40 per cent. of the cases, shows that the tonsils are a fairly common portal of entry for the typhoid bacillus. In some very exceptional cases the ulcerative lesion of the pharynx seems, in association with the fever, to be the only localisation of the infection (pharyngo-typhoid). Although the bacillus has been isolated in the tonsillar exudate (Gallois) these lesions should be regarded as the result of a secondary growth, as is also the case with the spleen (splenomegaly) and Peyer's patches.

The old opinions relating to the modes of infection and penetration of the system by the typhoid bacillus have been modified or rendered more accurate by modern research. It was for a long time believed that the typhoid bacillus grew plentifully in the cavity and walls of the intestine, and thence disseminated the toxins which poisoned the patient. In reality this mode of infection, which is that of bacillary dysentery and cholera, is not applicable to typhoid fever.

The growth of the typhoid bacillus in the intestine is inhibited by the co-existence of bacteria which live there.

Among these hostile micro-organisms the B. coli in particular should be mentioned. This struggle between the saprophytes, which can easily be verified *in vitro*, takes place in the same manner in the digestive tube. Moreover, if a search is made for the typhoid bacillus in the body after death, it is found that the pathogenic microbe *diminishes in frequency towards the lower end of the intestine.*

In reality, the typhoid bacillus after being absorbed by the digestive tract finds a secondary habitat in the viscera, after having first passed through the blood.

This septicæmic period appears to be a silent one.

As the result of systematic cultures of the blood the typhoid bacillus has been isolated during the incubation period, and in the absence of any symptoms, several days before the appearance of the prodromes of the disease. It has also been found in the blood of some healthy subjects who have been contaminated, but nevertheless escape typhoid fever (J. Louis), doubtless because they possess a certain degree of immunity.

From the blood the typhoid bacillus is carried into all the organs and also into the central nervous system. It settles by choice in Peyer's patches, corresponding mesenteric glands, spleen, bone-marrow, liver and gall-bladder.

The presence of the typhoid bacillus in the patient's blood was noted a very long time ago, during life, by

J. Teissier, Busquet, Castellani, Warfeld, Courmont, Lemierre, etc., and after death by H. Vincent.

As soon as the febrile symptoms appear, the bacillus is almost constantly present in the blood. Coleman and Huxon, in the examination of eighty-five cases, found it

during the first week in 93 per cent.
„ „ second „ 76 „
„ „ third „ 56 „

It may also be found by cultures for a period of one to four days in the blood of animals infected experimentally.

The early appearance of the typhoid bacillus in the blood thus shows that the specific enteritis, *i. e.* the period of diarrhœa with necrosis of Peyer's patches and intestinal hæmorrhage *is preceded by a very important stage of bacillæmia.*

It is necessary to bear this explanation in mind if one wishes to understand the means by which the typhoid bacillus can be eliminated and thus spread the contagion.

After having invaded the blood, the bacillus is carried by it to all the viscera. From the epidemiological standpoint *this is a fact of great importance, for some of these viscera have excretory ducts or organs which communicate with the exterior,* e. g. the liver by means of the gall bladder and common bile duct, and the kidneys by the ureters and bladder.

From the onset of the disease, and indeed even *from one to twenty-five days* (in cases with a long incubation) *before the appearance of febrile symptoms, the typhoid patient is contagious,* and eliminates the pathogenic bacillus in his excreta.

It is unlikely, at least at this initial period, that these bacilli come exclusively from the mucous membrane and glands of the intestine.

On the other hand, from the moment that the bacillus invades the blood, *the liver and gall bladder form the principal route for elimination of the bacillus of typhoid fever.* The bacillus is also to be found in great numbers

in the stools, to which it communicates their contagious character.

The conveyance of the bacillus to the gall bladder in which it grows is effected, not by the ascending route, *i. e.* from the intestine to the gall-bladder by means of the common bile duct, but by the liver, or, according to Chiarolanza, by the blood capillaries of the submucosa, where they perhaps form emboli, which facilitate their passage into the gall-bladder.

Lemierre and Abrami hold that damage to the hepatic parenchyma allows the passage of the bacillus into the bile.

Whatever may be the means by which it is conveyed, the almost constant presence of the bacillus in the bile remains a well-proved fact.

It may be absent, but this is a rare occurrence. When it reaches the gall-bladder it grows there as readily as in a culture-tube, finding a suitable medium which is constantly being renewed and eliminated, and thereby carries the bacillus with it into the duodenum and discharges it with the excreta.

An attempt has been made by means of experiments to elucidate the problem, which is so interesting from a pathogenic and epidemiological point of view, of the existence of the typhoid bacillus in the gall-bladder. As a matter of fact, animals form an unsuitable field for inquiry, because, with the exception of the monkey, they present a very low susceptibility for typhoid infection. Though very sensitive as regards the toxine, it is only under very rare and special circumstances that they show symptoms of true septicæmia.

Investigators, however, have succeeded in injecting the typhoid bacillus into the vein of a rabbit, and finding it in the gall-bladder when the animals were killed at different dates. Thus the bacillus has been found to persist in the bile of a rabbit for three and even four months. This long persistence of the bacillus in an animal is doubtful, and the same experiments have by no means given a similar result in the hands of other writers.

In man the existence of the typhoid bacillus in the

contents of the gall-bladder may be found by cultures after death. In the patient, Boldyreff's test, *i. e.* the injection of 200 grammes of oil, causes a reflux of bile into the stomach, from which the bacillus can be isolated. It has been possible to find the micro-organism by this method, even when examination of the stools had been negative. Lastly, Carnot and Weill-Hallé have introduced a very interesting method by which the typhoid bacillus can be sought for and isolated in the duodenum by means of a rubber tube.

An explanation is thus obtained of the presence of the typhoid bacillus in a patient's stools. The chief sources from which the bacillus comes are: (1) Infected bile; (2) Intestinal ulceration; (3) Extravasation from the capillaries of the intestinal submucosa (Chiarolanza).

This elimination, which is so important from an epidemiological standpoint, can be verified by cultivation of the stools.

The date of appearance of the typhoid bacillus in the stools is very early, its presence having been observed before the febrile period and even before the first symptoms.

We may remind the reader that typhoid fever is preceded by an incubation period which may be as short as fourteen or fifteen days, but which may be prolonged to three or four weeks, or even forty or forty-five days. The result is that the subject who is incubating typhoid fever may have been disseminating the pathogenic bacillus by direct or indirect contagion for a long time without there being any signs to reveal it.

As soon as the symptoms of the disease appear, and the typhoid diarrhœa sets in, there is an abundant elimination of the bacillus, especially during the attacks of diarrhœa. In cases in which the biliary secretion is increased the intestinal content is rapidly eliminated and is very rich in bacilli.

The liquid character of the fæces facilitates their dispersion, and consequently the likelihood of contagion among those who are looking after the patient.

The excretion of bacilli is most copious during the

first fortnight, and then diminishes. Some writers think that the maximum frequency of the bacilli in the stools occurs at the onset of convalescence (?). It is women especially who have been weakened by a protracted attack of typhoid fever who eliminate most bacilli.

We may conclude from the foregoing that the patient excretes the bacillus and that consequently he is contagious before the appearance of the febrile symptoms and throughout the duration of his infection.

In hospitals patients suffering from characteristic forms of typhoid fever are usually isolated and are subject to precautions which remove or restrict the dangers of contagion. But in families, especially in poor families or in the country, the contagion may spread with extraordinary facility.

Hence those epidemics in families or villages in which a large proportion of the members or inhabitants are successively attacked. Individuals who have mild forms of the infection which are known as abortive, attenuated (*typhus levissimus*) or ambulatory, constitute some of the most dangerous agents of contagion because they are unrecognised. Such patients may be walking about and even be engaged in their ordinary occupations for several weeks, while they are disseminating the bacilli in their excretions, contaminating their neighbours and sometimes creating fresh foci of infection at a distance.

Children often serve as unrecognised agents in the dissemination of the typhoid bacillus by means of their excreta. Contrary to the generally accepted view they are very susceptible to this disease. Usually, however, they have only slight attacks accompanied by a weak febrile reaction, but on the other hand by diarrhœa, which may be profuse.

The *stools* of patients suffering from typhoid fever consequently form *the most important means of contagion* on account of the bacillus which they contain.

There are other means of contagion which we will now discuss.

It is well known that typhoid patients in the course of their disease fairly often have albuminuria and bacilluria. Although these two phenomena are not invariably associated, they may accompany each other. The discharge of typhoid bacilli in the patient's urine was described long ago by various writers (Neumann, Petruschky, Richardson, Wright and Semple, etc.). As in the case of the fæces, though in a less degree, the isolation of the typhoid bacillus in the urine presents difficulties. This is particularly the case when *B. coli* is also present. The presence of the typhoid bacillus in the urine of patients varies. Wright and Semple found it in five out of six patients.

Other authors isolated it in only 19 per cent. (H. Vincent). As in the case of the gall-bladder the bacillus may multiply in the bladder and cause an inflammation of its walls and even hæmorrhagic cystitis.

Cases of hæmorrhagic nephritis due to the growth of the bacillus in the renal parenchyma may also be observed in the course of typhoid fever.

In these various cases *the urine becomes a factor of contagion which is by no means negligible.*

The appearance of the typhoid bacillus in the urine in typhoid fever is not so early as in the biliary secretion. Whereas the bile forms a favourable culture medium for this bacillus—a property taken advantage of for the isolation and cultivation of typhoid bacilli (and paratyphoid bacilli)—the same cannot be said of the urine, which is an acid and innutritious medium.

It is none the less true that the passage of the typhoid bacillus into the patients' urine may play a part in the transmission of the disease.

It will be seen later that the typhoid bacillus may persist sometimes for a very long period after recovery in the gall-bladder, and consequently in the stools, as well as in the bladder and urine.

There are a certain number of atypical forms of infection due to the typhoid bacillus, which undoubtedly have a share in the transmission of typhoid fever. Such are the cases of septicæmia without intestinal

lesions, of which examples have been published, and certain forms of appendicitis (Drigalski, Stokes and Amick), suppurative otitis, bronchitis with obstinate bronchorrhæa without signs of typhoid fever, etc. Netter has observed instances of vulvitis due to the same infection in little girls.

More closely associated with typhoid fever are the late typhoid infections of the gall bladder and bile ducts, which very often occur in an apparently spontaneous manner and independently of any previous attack of typhoid fever. The typhoid bacillus has none the less penetrated into the organism at some time or other, sometimes without causing any immediate reaction, sometimes giving rise to a slight and overlooked affection, but in any case after a phase of latent septicæmia.

The importance of these foci of contagion from an etiological and hygienic point of view cannot be denied. By isolating the typhoid bacillus from the bile, after operations and at autopsies on patients suffering from hepatic colic, acute or chronic angiocholitis, cholecystitis and jaundice, Dupré, Dauriac, and Gilbert and Fournier made a highly valuable contribution to medical science, whereby this class of patients may be classified as *germ carriers*. The bacillus has been isolated from gall stones.

Paratyphoid bacilli also may be responsible for the same lesions. A certain number of cases of surgical contagion shows that this factor is not an exception (Ribadeau-Dumas and Debré). Wherever the typhoid bacillus can grow, and in whatsoever condition it may multiply, such as cholecystitis, suppuration, abscesses, osteitis, or periostitis, thyroiditis, parotitis, etc., it is liable to be contagious.

But transmission of contagion in this manner is much less frequent than by the fæces or urine.

It is not unreasonable to suppose that the typhoid bacillus may exist in other pathological products, or be propagated by other natural secretions. It may occur in the blood from epistaxis or intestinal hæmorrhage.

The pharyngeal lesions occurring at the onset or in the course of typhoid fever, such as Duguet's ulcers, may explain the presence of the bacillus in the saliva in which Dvouyeglasoff and Chantemesse have found it, the former in two out of fifteen cases, on the twelfth and twenty-fifth days of disease. Manicatide, who took cultures from the pharyngeal and tonsillar secretions of fifty-one patients, isolated the bacillus in thirty-six cases. Gallois has insisted on the importance of the rhino-pharyngitis, which is a fairly frequent prelude to typhoid fever. Systematic cultivation of the saliva, however, by other writers, did not show the bacillus.

Do the bronchial secretions of patients with pulmonary complications contain the bacillus?

Jehle says that he found it in nine out of fifteen cases after death. We have already alluded to the fact that certain forms of bronchitis, with abundant expectoration, are rich in bacilli.

As a matter of fact, pulmonary complications occurring in typhoid fever are due to secondary infections of the parenchyma or bronchi. Bacteriological examination shows the staphylococcus or streptococcus, which are the real cause of these infections, and in cases of pneumonia the pneumococcus alone (H. Vincent). The typhoid bacillus is found in the lung, but not as a rule in the spitting-cup. If, however, the lesion is accompanied by ulceration or hæmorrhage, the typhoid bacillus may be entangled in the pus or blood, and thus become an exceptional agent of contagion.

The same remark applies to the healthy and damaged skin (bed sores), and the sweat, in which Sudakoff and Wigura isolated the bacillus.

But contamination by fæces and bath water are sufficient to explain its presence on the surface of the skin.

In the case of two nursing women suffering from typhoid fever, Chantemesse and Widal were unable to discover the bacillus in the milk, but Lawrence says that he isolated it in one case of the kind.

Bilious vomit may contain the bacilli in very large

numbers. This vomiting, which occurs at the onset of typhoid fever, is connected with the infection of the bile passages. The reflux of bile into the stomach and its hyper-secretion brings with it a number of contagious bacilli.

We may conclude from the foregoing that the typhoid bacillus is eliminated by the patient before any symptoms appear, and throughout the duration of the disease.

The contagiosity of patients suffering from typhoid fever is consequently due to the presence of the typhoid bacillus in the excreta, urine and vomit, and in an accessory degree in the other secretions, including pus and other pathological products. The patients' dejecta constitute the most dangerous elements in the transmission of the disease.

The corpses of persons who have died of typhoid fever are, for an indefinite period, it is true, sources of infection of the soil and subsoil water, to which they contribute an enormous quantity of germs. But it must be stated that this mode of infection is limited owing to the feeble vitality of the typhoid bacillus outside its natural culture medium, the human body. On the other hand, we do not know of any animals which spontaneously contract typhoid fever, which is, therefore, a pre-eminently human disease. Moreover, in the presence of the micro-organisms of putrefaction and those of the soil, the typhoid bacillus does not survive for long. It dies as the result of a struggle for life with the other bacteria. It is, indeed, a general law that most pathogenic microbes, and especially the micro-organisms, which are pathogenic for man exclusively, cannot multiply outside the human body. Some survive in this external medium for a comparatively short time, but all die and sometimes very rapidly.

The result of this is that the contagion of infectious diseases demands for its realisation an assemblage of conditions which can easily be determined, in the majority of cases, when the pathogenic agent can be

cultivated and isolated by laboratory methods. Such is the case in typhoid fever. This possibility of determining the presence of its pathological micro-organisms has enabled us to study in detail another important factor in its transmission, the "germ carrier."

CHAPTER IV

ETIOLOGY OF TYPHOID FEVER (*continued*)—THE HUMAN FACTOR—THE RÔLE OF CARRIERS

THE bacteriological researches which have been made by a large number of investigators have clearly proved the effective survival of the typhoid bacillus in the patient, in spite of his recovery from the disease. It has already been shown that some cases of periostitis or osteitis occurring sometimes even several years after recovery from typhoid fever might contain the living bacillus. On the other hand, a long time ago a certain number of French physicians established the relation existing between acute or chronic biliary infections, cholecystitis or cholelithiasis and the typhoid bacillus which they had isolated by cultures (Dupré, Langlois, Gilbert and Fournier, Faitout and Ramond, Sacquépée, Carnot, etc.).

Epidemiological observations and the undoubted transmission of typhoid fever by healthy subjects who had had the disease a long time ago, led to an inquiry as to the explanation of this method of contagion.

The subject who has recovered from typhoid fever, or from one of the atypical forms of this infection, the individual who had been merely touched, as it were, by the bacillus, but had nevertheless given it a shelter, however brief it might be, in his blood, gall-bladder, renal pelvis or bladder, is not always freed from the infective agent by the mere fact of his recovery.

In a fairly large number of cases the bacillus may survive the disease. *Clinical recovery does not mean bacteriological recovery.* And thus we find the explanation of the abnormal prolongation of certain epidemics,

of "typhoid fever houses," of cases of contagion hitherto unexplained, and apparently spontaneous cases. All are due, or may be due, to the conveyance of the typhoid bacillus by *bacillus carriers*.

We must now make a study of those healthy subjects who are unconsciously carrying the pathogenic organism, disseminating it about them and are thus becoming dangerous agents of its transmission.

When the fæces of persons recently recovered from typhoid fever are grown on an appropriate medium, colonies of the typhoid bacillus may be found in some of the specimens.

Further examinations show, though not invariably, the persistence of the bacillus in their excreta. Such persons are germ carriers.

The first researches on germ carriers were made by Remlinger and Schneider in 1897 at the Val-de-Grace School. On examination of the fæces of ten soldiers who had been treated for various affections, these observers isolated the typhoid bacillus in five cases.

In a publication which appeared shortly afterwards Prof. Lemoine, of the same school, also found the bacillus in the fæces of a certain number of patients who were not suffering from typhoid fever, tuberculous patients in particular. One of us also isolated the bacillus from the excreta of a healthy subject in 1893.

In 1904 Clerc and Ferrari found the bacillus in six out of thirty-two persons who were in charge of typhoid patients.

It was not till several years afterwards that these researches were universally confirmed and demonstrated the existence of the bacillus in a fairly high number of "carriers."

In 1903 Decobert also drew attention to the existence of convalescents from typhoid fever who showed the bacilli in their fæces. He found the typhoid bacillus for fifteen to twenty days, and in one case for more than a month after the temperature had become normal.

Braun found one patient in twenty, and Sicre one in ten, who still showed the bacillus in the fæces after

recovery from typhoid fever. Sacquépée found two chronic carriers among eleven patients, etc.

The origin of the typhoid bacillus which has been thus eliminated in the fæces is in the gall bladder.

In this cavity, where the bacillus finds a nutritive medium in which it can grow, the microbe lives and multiplies and can be found long after recovery, just as, in the course of the disease, in the dejecta. The proportion of bacilli contained in the stools of germ carriers may be considerable. Researches made at the laboratory of the *Army Medical Advisory Board* show that carriers can eliminate daily from 30–190 millions of bacilli per gramme of excreta.

The excreta of the carrier thus become the efficient cause of typhoid fever on every occasion on which they come in contact, directly or indirectly, with the healthy subject. This is the explanation of some persistent endemics, especially in villages, families, camps, and cantonments and trenches in war time, in spite of an early removal of the sick, the disinfection of excreta and soiled linen, and the sterilisation of drinking-water.

The bacillus is also conveyed by persons suffering from ambulatory, abortive or atypical forms of typhoid fever in which no precautions are taken. It is no less certain that men in the incubation stage or at the onset of typhoid fever are very dangerous propagators of the bacillus, especially in war time, when soldiers frequently refuse to consult the doctor from a variety of motives, whether through fear of having their suspicions as to the nature of their disease confirmed, or because war has accustomed them to neglect their physical sufferings, or because they are too proud to seek advice. Some men do not report themselves sick until their strength entirely gives way. It is thus that we find cases of acute peritonitis, or of sudden death from myocarditis in patients suffering from typhoid fever.

Convalescents and persons who have recovered from the attack many years previously act as carriers of the typhoid bacillus.

Their rôle in the propagation of the disease is not exclusive. It is not, however, a negligible one, and in circumstances which we shall discuss later it is predominant.

There are two groups of bacillus carriers: *the biliary* or *fœcal* carrier, and the *urinary* carrier. The growth and persistence of the bacillus in the urine are due to the same causes as the survival of the typhoid bacillus in the bile.

German hygienists have made a distinction between "primary" germ carriers, *i. e.* those who had never been ill, and "secondary" carriers, *i. e.* those who had previously had typhoid fever. This distinction has no practical interest and, further, by the suggestion that the bacillus has escaped from the body without having caused a previous infection of the blood, however short-lived and slight it may have been, is not in conformity with facts. In carriers who have never had typhoid fever there is always a period of blood infection which precedes the growth in the gall bladder.

As we have seen, in epidemic times individuals are to be found who have the bacillus in their blood, although they are free from typhoid fever. Further, the serum test is positive in a certain number of healthy individuals, which also proves in another manner the reality of the infection.

We will now discuss *temporary* carriers and *chronic* carriers.

The duration of the persistence of the typhoid bacillus in the stools of germ carriers varies considerably. It ranges from a few weeks to months or years. It may even continue throughout life.

After recovery from typhoid fever the bacillus either disappears from the stools—the most frequent event—or it may still persist in them. The proportion of those in whom it persists is from 4 to 5 per cent. Park estimates this number at 6 per cent. Of these a third (2 per cent.) keep the bacillus for several weeks or two to three months. About 1 per cent. remains a carrier from three months to a year. Beyond this date the

number of chronic carriers is a little more than 1 per cent.

The statistics obtained by examination of the stools vary with the observers. Cases in which the bacillus may be found in the excreta for ten, twenty or thirty years, and even longer, are doubtless less numerous, but are by no means exceptional.

The predominance of typhoid carriers in the female sex is a well proved but unexplained fact. The difference between the two sexes is considerable. On the other hand, the number of carriers among children is much less than among adults. Children aged eighteen months have been found to be carriers.

If chronic carriers only be considered, 79 per cent. are women and 21 per cent. men.

A similar examination made among children showed that 4 per cent. were chronic carriers.

Frequent cultivation of the stools of carriers fairly often shows that there are periods during which no elimination takes place.

This disappearance of the bacilli occurs very irregularly. Absence of bacilli may be noted at the *onset* of convalescence, and their presence several months afterwards.

Subsequently the presence of the typhoid bacilli in the fæces is also sometimes continuous and sometimes intermittent.

Intervals of varying length occur which may last one or more weeks and even two or three months, followed by a return or even a considerable increase in the number of bacilli eliminated. It is obvious that germ carriers are dangerous during these periods of activity. D. S. Davies and Walker Hall have even thought that their period of contagiosity was related to the seasons (from May to November in England), but this view has not been confirmed.

It is therefore necessary for the detection of carriers to have recourse to repeated examinations for a fairly long period, *e. g.* six months to a year at least.

This, it must be admitted, is a method of difficult

application in a large community, especially when one considers that the isolation of the typhoid bacillus from the stools requires some experience owing to the frequent presence of bacilli of the paracoli group and *B. fæcalis alkaligenes*, which grow abundantly in the intestine, and on superficial examination may be classed as typhoid bacilli. The agglutination test has, therefore, been recommended, as it is positive in a 1 in 100 dilution among three-quarters of the carriers.

Carriers chiefly consist of persons who have recovered from the disease some time previously. But it has been said that persons who have never had typhoid fever may also harbour the bacillus. Their attack has been mild or unrecognised and left this latent condition as a residue.

It has been noticed that such carriers are chiefly found among persons who have been near typhoid patients, such as nurses, male or female attendants, doctors, and generally any persons who have been attending them.

Sometimes carriers themselves have been known to contract typhoid fever.

The duration of the persistence of the typhoid bacillus in the gall-bladder varies considerably. Although, as a rule, its persistence does not exceed three months, a certain number of carriers remain infected and infectious for ten or twenty years and even more. Some keep and discharge the bacilli throughout life. Donald Gregg reported in 1908 the case of a woman who had had typhoid fever in 1856, but had been in good health since, except for attacks of migraine accompanied by diarrhœa, and who still had the typhoid bacillus in her stools after fifty-two years.

These temporary or chronic carriers thus become the starting-point of isolated or epidemic cases, either in their home surroundings or in places in which they may have stayed for only a short time. They may transmit the bacillus by direct contagion or by agents of various kinds.

Carriers, therefore, play an important part in the

propagation of typhoid fever. The modes of contagion are obviously similar to those which are due to actual patients who are, properly speaking, carriers. There is, however, an important distinction between the two. Patients being isolated and compelled to stay in bed cannot by themselves spread the disease. They may directly infect those who come near them, but the conveyance of the germ to the outside world depends upon the fate of the excreta in which it is mixed. Every object which has served for the personal use of the patient thus becomes an actual vehicle for the bacillus (bed linen, basins, etc.). The germ carrier, on the other hand, is not deprived of movement by disease, but goes from place to place, and may take the bacilli wherever he deposits his excreta. Patients are under close observation, their condition attracts attention and involves special precautions and measures of disinfection, whereas germ carriers escape recognition.

It may be mentioned that the typhoid carrier does not, as a rule, excrete so large a number of bacilli as the typhoid patient, except during periods of diarrhœa, in which the amount is considerable. Some carriers, however, have unintermittently an enormous quantity of bacilli in their stools and in almost pure culture.

It has been urged that the bacilli discharged by germ carriers are less virulent and less active than those eliminated by the patients. This hypothesis is not verified by facts. Numerous family epidemics which have been caused by the direct contagion of germ carriers have given rise to fatal cases.

The foregoing remarks apply also to urinary carriers.

The persistence of bacilluria after recovery from typhoid fever is from a few weeks to several months or several years (Youdalewitch, Wright and Semple, Richardson, H. Vincent). Contagion by urinary germ carriers, however, is less frequent and important than by carriers of biliary origin.

Instances of contagion due to both have been quoted in every country.

It has been observed that epidemics or endemics recur, sometimes every year, in the immediate neighbourhood of germ carriers.

Among the histories of epidemics published, one of the best known is that observed in 1907 by Dr. Soper, Medical Officer of Health for the City of Boston. A cook who had had typhoid fever in 1900 gave rise to thirty-eight cases of typhoid fever in the various families in which she had successively been employed since her recovery.

D. Gregg's case, who had had typhoid fever in 1856, gave rise to seven cases of the same disease in her immediate surroundings between 1905 and 1908, or fifty-two years after her infection.

Huggenberg has recorded the case of a woman in Central Switzerland who had had typhoid fever thirty-one years before and still presented bacilluria. She had transmitted typhoid fever to her husband in 1886, to her son in 1892, to four servants from 1899 to 1902, to her daughter-in-law shortly after coming to live with her, and in 1903 to 1905 to four other servants. In 1908 a fresh case of contagion was found in a servant. No case occurred in her immediate surroundings between 1905 and 1908, but at that date her servants were already infected.

W. Park, Director of the New York Department of Health, has published a very similar case to that of Soper.

The case was that of a cook, who declared that she had never had typhoid fever. She nevertheless caused an outbreak of typhoid fever in seven of the eight different families in which she was successively employed. The total number of cases to which she thus gave rise was as high as twenty-eight.

Her blood agglutinated the typhoid bacillus, which was also found in the excreta. She had to be isolated in the North Brothers Island Hospital.

In the Report on Epidemics to the French Home Office, H. Vincent (Académie de Médecine, 1909) recorded some cases of contagion due to carriers, sick

and otherwise. Direct contagion from man to man is the rule in the country.

At Castelfranc, a village of 463 inhabitants, in the Lot Department, a girl aged ten, who had come from another village in which there was an epidemic caused by the water, infected six living in her house or neighbouring houses.

In Cévan a young child, who had been infected in another village by her nurse, gave rise to six cases. The child of the new nurse, three brothers and sisters, the nurse's mother and servant were infected in succession.

Courtois-Suffit and Beaufumé have published the account of an epidemic transmitted by a germ carrier. After her arrival in a village in the Yonne Department she gave the disease to fourteen persons in her family or in the neighbouring houses.

Numerous descriptions have been published of epidemics due to germ carrriers in schools, seminaries and lunatic asylums. The army is not exempt. Netter recorded the outbreak of twenty-one cases which occurred without obvious reasons in one out of three batteries in a garrison in the East of France.

The food and water supply were common to the three batteries, moreover the drinking water was sterilised. But the infected battery contained a young soldier who had had typhoid fever seven years previously and whose stools contained numerous bacilli.

The same author has also given an account of an epidemic on board a Japanese man-of-war, due to two carriers. When these had been isolated, the epidemic disappeared.

In 1908 a certain number of cases of typhoid fever having occurred at Aldershot Camp, without obvious cause, all the men were examined. One of them had bacilli in the urine. He had contracted typhoid fever in Aden in 1904. He was isolated and the epidemic ceased.

In August 1901 a young soldier, who had typhoid fever three months previously, arrived in England

from South Africa. A fortnight later three sisters and two brothers of the patient, a young servant, the cook, a friend and two persons living in the next house were attacked in succession. The young soldier's urine contained 175 bacilli per c.c. The infection had occurred as the result of the well water, which communicated with the water closet.

The attention of English doctors in India has been directed to typhoid bacillus carriers.

Typhoid fever was very frequent among the troops, since prior to the adoption of preventive inoculation there were at least 1000 cases yearly (not including the much rarer cases of paratyphoid fevers A and B), with the result that every year germ carriers were left to carry on the disease.

For this reason ever since 1908 convalescents from typhoid fever are sent to the special depot at Naini-Tal, which is isolated and provided with a disinfecting apparatus and a laboratory. The urine and fæces are examined there every week, and patients who have recovered from typhoid fever are kept here for four months.

Most of the men keep the bacilli in their stools for a few weeks only. Chronic carriers, *i. e.* those who keep the bacillus for six months, are discharged from the service. Their proportion has been 3 per cent. After the first year (1908) a drop of 9 per cent. was observed in the incidence of typhoid fever among the units in which these precautions had been taken, while the others showed an increase of 26 per cent.

In a new Parliamentary Report (December 25, 1909) it was noted that the duration of the persistence of the bacillus necessitating discharge from the service had been lowered to three months. At the end of this time the man is discharged, unless he prefers to remain in hospital. The Medical Officer of Health for the district to which he goes on discharge from the service is notified of the case. It is to be feared that these carriers on return to civil life may become the starting-point of an epidemic.

Questions were raised in the House of Commons on the subject of soldier carriers who had been sent home from India and isolated at Millbank Military Hospital.

Public authorities have everywhere been much concerned about the danger likely to result from these carriers, owing to the absence of help hitherto afforded by prophylaxis. In France this problem has been studied by the Health Service of the army, and gave rise in 1910 to an important discussion at the Academy of Medicine. In England, Germany, Russia, Belgium, and the United States, especially at the State Board of Health of Iowa, sanitary legislation has endeavoured to find a remedy for the conveyance and propagation of typhoid fever by these carriers, but this special prophylaxis meets with very great difficulties, as may well be understood.

Families and persons living in immediate contact with the carrier are most exposed to the risk of contagion. Life in common leads, indeed, sooner or later, to direct or indirect conveyance of the bacillus to other persons.

It is, therefore, in poor families, in working-class households, or in the country that contagion due to carriers has most chance of developing.

In the army the rôle of typhoid (or paratyphoid) carriers in time of peace is certainly limited to a few special cases. But it becomes considerably more important in camps, and especially in war time, when the crowding together of a considerable number of effectives results in the soil being saturated with human excreta.

The chances of infection are thereby extraordinarily multiplied, especially when associated with even more important factors, such as the presence of those who are really suffering from the disease, both those who are under treatment, and still more so those who are not, *e. g.* soldiers in the incubation period and at the onset of typhoid fever, as well as those who have only an incomplete form of the disease. We have

thus an explanation of the disastrous intensity of the epidemics by which armies were formerly ravaged during even the shortest wars.

We have now to discuss those circumstances that favour epidemic contagion. After having studied the sources *from which* the typhoid bacillus *comes*, we must state *whither it goes*.

CHAPTER V

THE PRINCIPAL MODES OF DIRECT TRANSMISSION OF THE TYPHOID BACILLUS

After leaving the patient or the carrier, *the pathogenic bacillus of typhoid fever follows the path of the excreta and pathological products in which it is incorporated.* When it comes in contact with a susceptible person the micro-organism can exercise its infective power either in the immediate surroundings of the patient or carrier, or at a distance from its original focus.

The bacillus makes its way into the system either by direct or indirect contagion. The digestive tract is almost always the portal of entry. How does the infective agent gain admission?

The simplest mode of transmission is by direct contagion. Whether eliminated by a patient or a carrier, the micro-organism is, as a rule, communicated without any intermediary agent to persons in their immediate surroundings, such as relations, doctors, nurses, visitors, patients in the next bed, etc.

This direct contagiosity of typhoid fever was well known to the old observers, such as Louis, Gendron and Piedvache. On meeting with successive cases in the same family which were undoubtedly connected with one another, Louis, at the beginning of the nineteenth century, declared that typhoid fever was certainly contagious, at least in the country. Insufficient hygienic precautions, absence of cleanliness, the non-disinfection of excreta, and soiled linen furnish an explanation of this transmission of the micro-organism.

Direct contagion most frequently takes place when the patient is being attended to in connection with defæcation or micturition, the change of body linen or bedclothes, or when he is being carried to the bath.

It may also occur when he is given a drink, or his mouth and teeth are being cleansed, or a visitor shakes his hand which has been contaminated. Contagion occurring in hospitals, as a rule, is due to these factors. Numerous cases are recorded in which patients have been infected by offering their services to a typhoid patient in the next bed.

The carrier may directly transmit the germ in the same manner whenever he is suffering from a disease which requires similar attention, whatever its nature may happen to be. Likewise the patient who is suffering from suppuration due to the typhoid bacillus, or has been operated on for typhoid cholecystitis, etc., may transmit the disease to an attendant who does not take proper precautions.

On the other hand, the contagion may be conveyed by a male or female attendant, who is a carrier, to children or adults suffering from another infection. Uncleanliness is, indeed, almost always at the root of direct contagion. Furthermore, whatever the means by which the contagion takes place, *the hands are, after all, the receptive organs and transmitting agents of the typhoid bacillus*. The hands are contaminated by the particles of fæces, drops of the patient's urine, vomit, sputa, etc., and *without being washed* collect and convey the food to the mouth. For this reason it has been rightly said that, whatever may be the origin of the bacillus, whether from a patient or a carrier, *typhoid fever by contact is a disease caused by unclean hands* (H. Vincent). This statement is further confirmed by the fact that it is the carrier's unclean hand which manipulates the food, contaminates it with bacilli, and so passes it on to other persons about him.

The denomination of "epidemic by contact" has been given in Germany to those cases of typhoid fever which occur in the immediate neighbourhood of the

patient or carrier. This expression is incorrect, for it includes at once direct and indirect contagion. It should be reserved for those cases in which the conveyance of the bacillus takes place directly by contact of the patient with a healthy subject.

From this point of view direct contagion occurs in barracks only under exceptional circumstances, having regard to the other and undoubtedly more numerous risks of infection to which the soldier is exposed in peace time.

The danger of the germ carrier mainly depends on the mode of life of the carrier himself and of those with whom he lives. Investigations made at thermal stations like Vichy, which are the resort of patients suffering from chronic hepatic affections and of active germ-carriers, have undoubtedly proved the extreme rarity of contaminations due to carriers. The fact is that the spread of the contagion of typhoid fever among neighbours is by no means comparable to that of some other diseases, such as diphtheria, cerebro-spinal meningitis, the eruptive fevers, mumps, etc. Whereas in the latter infections direct contagion plays the principal, preponderating, and even, in some diseases, exclusive part, the same cannot be said of typhoid fever.

In the carrier the typhoid bacillus, instead of being in direct and immediate contact with the outer air, is hidden in the gall-bladder and intestine, or in the bladder. It is eliminated intermittently and mixed with the fæces or urine. The result is that the conditions are less suitable for its reaching the outer world and for directly infecting the persons in the immediate vicinity. Such infection could only occur if the bacillus had its habitat in the carrier's saliva or nasal or pharyngeal mucus, which is not the case.

Consequently, direct contagion by the typhoid bacillus is restricted to well-defined conditions. It can only occur when particles of fæces or urine, conveyed by unclean hands or by bedpans or urine-bottles, are deposited on food, bread, etc.

The result is that, however important contact may be in the transmission of the bacillus discharged by germ carriers, the conditions which give rise to direct contagion are not very frequent.

Consequently, transmission by indirect contagion is much more important.

From the foregoing remarks it emerges that the rôle of carriers in the transmission of typhoid fever cannot be accurately defined, but that it is much more restricted than German hygienists maintain.

It is very difficult to get definite statistics on this subject. Some writers hold that contact with chronic carriers accounted for 30 per cent. of cases of typhoid fever; others for only 2 to 5 per cent., 6 per cent. (Park), etc.

But in all epidemics, *especially in those of prolonged duration, every cause of contagion, direct or indirect, is given full play*, and thus it is often impossible to incriminate one cause more than another in the presence of such varied etiological factors.

A second conclusion to be drawn from our discussion is that among the chronic carriers of the typhoid bacillus *the most dangerous are those who are engaged in trades connected with the preparation of food.*

On perusal of the cases of typhoid contagion due to carriers, one is struck by the high number of instances in which *male or female cooks* are concerned, as well as women in charge of the preparation of food, milking, etc. Waiters or servants in a restaurant, pastry-cooks, grocers, gardeners, and men or women employed on farms or dairies are some of the most dangerous carriers.

Women especially, as we have already said, have been found to be the most numerous among the carriers. In house epidemics, therefore, when the drinking water is wholesome, one must "look for the woman," as, owing to her occupation and domestic habits, she is accustomed to handling articles of food which are consumed raw and not heated.

Contagion of this kind requires an absolute or

relative lack of cleanliness, and the fæcal contamination of the carriers' fingers and hands.

In the army contagion from man to man by germ carriers also furnishes an explanation of certain cases of typhoid fever.

Instances have been quoted in the French army, but they are more frequent in foreign armies, especially the English army in India. Strange to say, although attention has long been directed to the possible rôle of chronic carriers, cases due to this mode of infection remain rare in barracks in peace time. For various reasons direct contagion is also uncommon. The proof of this is to be found in the numerous examples of a solitary isolated case of typhoid fever occurring in a barracks and not followed by any other cases. Besides, if carriers played a preponderant part, both in the army and the civil population, how are we to explain the seasonal course of the disease, its frequency from July to October, and its rarity or absence in the cold season? How are we to explain the fact that in the army the garrisons in the north of France are almost always free from typhoid fever, whereas those in the south, on the contrary, have numerous cases of this disease? The germ carriers, however, consisting of men who have formerly had typhoid fever and who still retain their bacilli, have been distributed indiscriminately in both these areas, and their influence should make itself felt in every season.

Consequently, in the army in peace time contagion, due to carriers, is most to be feared when some of these carriers are to be found among the cooks or cooks' assistants, or among those in charge of filters or apparatus for sterilising water, the canteen women, etc.

Apart from these special cases, it may be admitted that the shaking of hands, and use of spoons, forks or cups which have been touched by the unclean hands of carriers, may disseminate the bacillus, but such cases, on close examination, are infrequent.

On the other hand—and we cannot insist too much

on this point—contagion caused by temporary or chronic carriers finds the most propitious occasions in war time, when neither fæces nor urine are confined to latrines, or washed into the sewers, or kept in pails or water-tight pits.

In spite of severe orders and constant watching, human excrement is to be found everywhere—on the ground, in cantonments, gardens and lanes, on the edges or in the bottom of ditches and in the fields—and from these sources the bacillus finds its way to man.

Whatever its original source, whether a person in the incubation stage, a patient at the onset of the disease, or with an abortive, mild or ambulatory attack, or, lastly, a convalescent or a chronic carrier, the conveyance of the bacillus to the healthy man is brought about in such a case by very varied agencies.

It is these agencies which we shall now discuss.

CHAPTER VI

INDIRECT CONTAGION BY PATIENTS OR CARRIERS—INERT FACTORS IN THE TRANSMISSION OF THE TYPHOID BACILLUS

In the hierarchy of the factors of contagion which enter into the etiology of typhoid fever, it is not permissible to dethrone some at the expense of others. It is certainly due to an excessive abuse of the German doctrine, which in itself is exaggerated, that such important agencies as drinking-water, flies, etc., were denied their proper share in the transmission of the typhoid bacillus.

The bacillus, from whatever source it may come, is carried away with the fæces and urine, and accompanies them wherever they go. When discharged outside the body, it does not find the conditions to enable it to live and grow which existed in its human medium. The soil, the air in which it is mixed with dust, water, vegetables, animals and clothes serve to protect it. The duration of its vitality in such an environment has formed the object of numerous researches, which show little agreement with one another and are sometimes divergent.

These differences can be explained by the fact that, owing to the difficulty of isolating typhoid bacilli, many observers have worked with pure cultures in the presence of sterilised earth, water, etc., thus performing experiments which in no way correspond to natural conditions. Other writers may have confused the typhoid bacillus with some other bacteria (paracoli bacilli, or *B. fæcalis alkaligenes*), which are common in fæces, manure, dung-heaps, and putrefying organic matter.

Lastly, these investigations were made for the most part at a time when the differential characters of cultures on sugar media, neutral red agar, etc., had not yet been determined.

We can, therefore, perhaps attribute only a relative value to researches on the vitality of the typhoid bacillus outside the human body.

The average period during which the bacillus survives in fæces and water-closets is from twenty-five or thirty days to five months (Galvagno and Calderini); in the soil five months (Grancher and Deschamps); in sand, street or house dust, and dry sawdust one to two months; in buried corpses fifteen to twenty days according to some observers, ninety-three according to others, etc.

All these investigations undoubtedly require revision, because the typhoid bacillus is very fastidious in its conditions of existence, and does not live long in the presence of ordinary micro-organisms.

It has been easier to study the influence of heat, cold and light on the typhoid bacillus.

It is killed instantly by boiling. At a temperature of 57 to 60° C. it is killed in an hour, but not, as a rule, after exposure for the same time to a temperature of 53° C.

When exposed to the action of the sun on dried earth it is killed in five to eight hours; porous or sandy soil is more favourable for its destruction. On cotton or linen exposed to direct sunlight it survives for from two to twenty-six hours; on black cloth from nine to eleven hours (H. Vincent).

The natural bactericidal action of the sun on the typhoid bacillus is, therefore, well established.

When deposited on linen, clothes, etc., the typhoid bacillus survives for a comparatively short time, but sufficiently long, however, to produce contagion.

Clothes, such as sheets, drawers or bedclothes, which have been soiled by a typhoid patient or germ carrier can infect persons who have to handle them, such as servants, and especially laundrywomen. Cases

of typhoid fever were formerly common among hospital laundrywomen.

Cases are on record of contagion taking place from the wearing of infected clothing. Mortchrowski has related the case of a reservist who contracted typhoid fever from wearing the shirt of another soldier who was suffering from this disease.

Thus clothes and boots and shoes worn by a typhoid patient or a carrier and contaminated by fæcal matter can infect a healthy subject. The typhoid bacillus persists from ten days to four months in books, but is killed in twelve to twenty-four hours if exposed to the light of the sun (Laubach of Baltimore). This mode of contagion by books is probably very rare.

Contagion of the soil by specific excreta is very common, especially in the country, where the general rules of hygiene are so often neglected.

In towns removal of fæcal matter is usually carried out perfectly when a drainage system exists, but imperfectly when the fæces are collected in leaking cesspits or pails. In the last two cases they remain harmful, and the bacillus which they contain may find opportunity for passing through into the soil or reaching man by the agency of flies.

Removal of excreta into the street presents the gravest dangers. This method is practised in some badly supervised towns, in the suburbs of some large towns, and some workmen's dwellings. All who pass by get infected particles caught on their boots, take them into the house and contaminate their hands.

Children, owing to their practice of defæcating everywhere, are the chief propagators of this street pollution.

In the country the contamination of the soil by fæcal matter is continually occurring. The excreta of patients or carriers are often deposited in front of the door, in the vegetable garden, or on the dung-heap. Removal of the house refuse into the street or gutter is commonly practised. The specific contamination of the soil by the typhoid bacillus finds its way

back to man by the agents already mentioned, viz. boots, clogs, bare feet, hands, vegetables, drinking-water, etc.

In barracks we find a possibility of indirect fæcal contagion by the latrines. They are often in a dirty state, and when a man goes to relieve himself he risks contaminating his boots by the side of the latrine.

Camps and cantonments, both in war and peace, provide the same opportunities for infection. If the soldiers, as frequently happens, deposit their excrement not in the fæcal trench but near it, and in addition to this the rain soaks the soil, every visit to the fæcal trench is the occasion for a more or less dangerous "microbial foot-bath." The habit which soldiers have of cleaning their boots with pieces of wood, or even with their knife, exposes them to specific contamination of their hands, especially the parts beneath their nails and between their fingers.

In camps and cantonments human excreta are only too frequently found near tents, barracks, houses, or in gardens.

War always remains the gravest efficient cause of this soil contamination, which almost invariably finds its way back to man.

The earth returns with usury the pollution which it has received. The straw used for the beds and the blankets are also contaminated. Pollution of the soil by specific fæcal matter was incriminated by Surgeon-General Derby, in the War of Secession; the troops occupying the camps abandoned by the Confederates contracted typhoid fever. The same cause was invoked in the war in Tunis; during the Russo-Turkish War, the atmosphere was sometimes rendered intolerable by the stench of the fæcal matter accumulated in the Turkish camps. At the time of the English Expedition to Egypt, the Medical Officers also noted the incredible filth of the abandoned Turkish camps.

During the South African War the extreme frequency of typhoid fever was explained by this same injurious influence of the soil, infection being attributed to the

inhaling and swallowing of fæcal dust containing the typhoid bacillus.

A similar cause was invoked by the principal Medical Officer, Millet, during a very severe epidemic in 1895 among the 14th and 15th Regiments of Dragoons during their manœuvres near Rheims on a dried-up plain covered with manure.

It is obvious that a recently dried typhoid bacillus may give rise to such infections if it preserves its vitality.

But at the present time only a very restricted rôle is attributed to this method of contagion. Some even deny it altogether.

Much more important is infection of alimentary origin, both by solids and still more so by fluids.

Typhoid fever which is accompanied by a discharge of excreta which are sometimes very rich in bacilli, readily leads to contamination of food substances by the patient or the carrier.

We have already discussed the contamination of food by unclean hands, and the conveyance of the typhoid bacillus into the alimentary canal of the healthy subject. The gathering of vegetables eaten raw (salad, radishes), the picking of strawberries or raspberries, and of fruit generally, by similarly contaminated hands, the preparation of meals, etc., all serve as occasions for depositing the typhoid bacillus in food.

There is another mode of contagion by vegetables, which is due to their being planted in a soil which has been manured with human dung, or has been watered with a mixture of fæcal matter and urine.

This is a deplorable practice, borrowed from the Chinese, which is the cause of numerous epidemic cases. The growing of cress in water similarly contaminated also offers grave dangers. In numerous countries the surface disposal of fæcal matter is carried out in a systematic manner; and this dangerous commodity is ladled out over the vegetables and the soil.

Examples have been quoted of epidemics due to the use of vegetables thus contaminated. In 1909 several cases of typhoid fever due to the consumption of raw vegetables were seen in the garrison at Vannes. The farmer who provided the vegetables was in the habit of watering them with the fæcal matter of his daughter, who was suffering from typhoid fever!

Unlike paratyphoid, which may affect animals, typhoid fever, being a disease confined to the human race, cannot be transmitted by meat, or only indirectly, *i. e.* if the meat after it has been cooked has been contaminated by the cook's hands or by flies.

On the other hand, *oysters* have been blamed, not without reason, for spreading typhoid fever. When they have been collected in the open sea, oysters are perfectly wholesome. It is by no means the same when their park is close to a harbour, and especially when they are laid close to sewer mouths and salt-marshes into which drain the residuary water of towns and villages, and with it the fæcal matter of typhoid patients and carriers. Johnston-Lavis, Netter, Chantemesse, Mosny, Remlinger, etc., have insisted upon this important cause of typhoid or paratyphoid fevers.

Netter has published striking examples of cases of typhoid fever in families or towns in which Cette oysters had been eaten. Similar cases have become so numerous that there is no need to mention them.

The increasing number of epidemics due to oysters is a striking occurrence.

In 1907 numerous cases due to the consumption of Cancale oysters were reported at Arras. Infection due to oysters also occurred at Abbeville, Mers, Treport, Eu, Sables-Olonne, etc. Several cases at Orthez, Oloron and Creusot were attributed to Cette oysters, and at Toulouse to Arcachon oysters. At Autun, which is a very healthy town, forty cases and one death were reported in October and November 1906; they were caused by the consumption of barrels of oysters which had been sent from Cette or the pond at Thaon.

The ingestion of raw shellfish, such as mussels, periwinkles or cockles, which have been kept in or collected from polluted water in the neighbourhood of sewers or in harbours, may also give rise to typhoid fever.

The special danger of oysters is to be explained by their mode of feeding. They feed on animalcules, living or dead organic particles, such as diatomaceæ, bacteria, etc., which are held in suspension in sea water. For this purpose their buccal apparatus is surrounded by four labial palps provided with vibratory cilia which draw into the stomach the food from the water. To obtain its food the oyster makes a prolonged aspiration, which enables it to pass through its digestive tube a very large quantity of water, from which it removes the principles in suspension.

If some living oysters are put in an aquarium filled with three to six cubic feet of turbid water, in a few days the water will become clear. The oyster, therefore, resembles an active filter which retains and concentrates the impurities. It is easy to understand how the oyster becomes loaded with numerous harmful bacteria, which it passes on to man when it has fed on highly contaminated water, such as that found in sewers or harbours into which fæcal matter is discharged.

Rôle of Drinking-water and other Liquid Foods.—Liquid foods, and especially *water*, play a very important part in the propagation of typhoid fever. Of all ingesta, drinking-water is the most responsible for epidemics. Ever since Brouardel's warning in 1877, countless facts have testified to the typhogenic rôle of this factor. "Drinking-water," said Guéneau de Mussy, "is an important, I might say the most important vehicle of the typhoid germ." In towns, large communities, and the army in peace time, drinking-water undoubtedly claims the first rank as the determining cause of epidemics of typhoid fever.

Like man himself, drinking-waters have their own microbial diseases, which are often due to a continuous

invasion of the micro-organism in question, while in other cases they are only temporarily contaminated by the dangerous products which they pass on to man. There are thus numerous occasions on which he may be infected, such as the swallowing of water, the consumption of raw vegetables on which specifically contaminated water has been poured, and various beverages, such as milk, cider or beer, diluted with impure water; and lastly, though very rarely, by bathing in contaminated water, of which he may absorb a certain amount.

In this respect it is obvious that water merely transmits the contamination which it has received. The causes for its pollution are very numerous, such as human excreta coming from patients or carriers, urine, laundry, sewers, etc. Surface water, whether running or stagnant, is most exposed to contamination of this kind. Deep waters, such as springs or water from the aquiferous stratum, may get pathogenic micro-organisms from the soil or latrines in their passage beneath the ground; artesian wells, on the contrary, are well protected, owing to their great depth.

Water intended for drinking does not, therefore, possess any special bacterial properties. Its purity depends partly on the geological strata through which it passes and the receptacles in which it is collected. In inhabited countries, where the pollution of the soil by micro-organisms extends to the water, the amount of germs in the water increases.

Bacteriological analysis of the camp subsoil water was made in 1892, in the camp of Hussein Dey, in which epidemics of typhoid fever were constantly occurring. Before the arrival of the troops the water was very pure, and contained only 200 ordinary bacteria per c.c. Six days later the analysis showed 770, thirteen days later 420, forty days afterwards 6960, sixty days afterwards 14,900, and three months afterwards 38,000 (H. Vincent). This is an illustration of the progressive infection of well water (phreatic

water), which is due to the presence of men on the surface of the soil, the duration of their stay, and the fæcal contamination which results therefrom.

The nature of the soil, whether calcareous, calcareous and fissured, or chalky, obviously influences its degree of permeability to the germs deposited on its surface and washed down by the rain. The soil, even at a depth of fifty metres, often effects but an incomplete purification of this water. From this point of view sandy soil is the best. But calcareous soil with large joints is permeable to the typhoid bacillus, even at a great depth.

A fissured soil which shows holes, cracks and crevices is dangerous in this respect, for it gives passage to unwholesome water and excrement diluted by the rain and deposited on the surface.

The holes of absorption into which a stick can be thrust with difficulty serve as passages for the surface waters (Martel), and so permit of the contamination of the subsoil water.

It is a well-established fact at the present time that, thanks to the permeability of the soil and the existence of holes for absorption, fissures and crevices, as well as subterranean currents, typhoid fæces may be very contagious, in spite of their being deposited at a great distance from the point of emergence of a spring. All the springs which supply Paris with drinking-water are exposed to this cause of infection. Fæcal pollution of one of the reservoirs, eight to ten kilometres from the spring, may contaminate it, especially after heavy rain. Rigorous and efficient protective measures have, therefore, been taken.

Waters of the Vauclusian type, *i. e.* those which, after running open to the air and so exposed to every possible cause of pollution, disappear into the soil and sometimes emerge again in a remote district, are especially dangerous (Martel).

The inhabitants of Sauve, in the department of Gard, thought they had discovered a spring when they were really drinking the water of their own sewer.

In the Jura Department, says Martel, all the springs are polluted by manure, night-soil, and the carcases of animals. A well-known example of a dangerous outlet is that of the Loue spring, which is merely the water of the Doubs, which disappears at Arcon. In 1901, when a fire destroyed an absinthe factory at Pontarlier, the spirit flowed into the Doubs, with the result that the Loue spring acquired a taste of absinthe.

Very numerous examples of springs with a reputation for purity (Avre, Vanne, etc.) have been shown to communicate with streams which flow sometimes on the surface of the soil and sometimes below. Thus the Lunain disappears after a course of ten to fifteen kilometres.

The typhoid infection of surface and underground waters is brought about by human fæces and urine deposited on the surface of the ground in pits near wells; it is also caused by cultivation of the soil and the dangerous practice of manuring it with dried human dung. The rain sweeps the ground, follows its declivities or infiltrates the soil, carrying pathogenic germs with it into the subsoil water.

Sometimes the well is in the immediate neighbourhood of a privy (P. Brouardel); certain towns, like Cherbourg, still show examples of the kind. Sometimes the laundry in which the linen of typhoid patients is washed is close to the spring from which the inhabitants get their water, when there is really a subterranean communication between the spring and the laundry. Water in ditches situated some hundred metres away from a spring may be seen to present oscillations of the same level, showing that both are connected with one another. Human residues and excreta percolate from one to the other.

We have given only a brief sketch of the commonest modes of adulteration of drinking-water. They easily explain the conveyance of the typhoid bacillus, its absorption sometimes in large quantities by the inhabitants of a town, village, barracks or school, and

the occasionally formidable outbreaks which result therefrom.

What becomes of the typhoid bacillus when it is discharged into water? Does it multiply, or retain its vitality?

All bacteriological investigations have shown that the typhoid bacillus hardly ever lives more than four or five days; sometimes it is impossible to find it after the third day.

The typhoid bacillus, therefore, does not long survive in drinking-water.

Moreover, the influence of diffuse light, and especially of the direct light of the sun (on rivers, ponds and lakes), has an energetic sterilising action. In clear water the bacillus is killed in four to six hours by the solar rays, and in eight to nine hours in turbid water. The actinic rays possess the most active power (death in two and a half to three hours), while the heat rays have a much weaker effect (more than fourteen hours) (H. Vincent).

But so long as it persists in the water the typhoid bacillus retains its pathological activity. Besides, it may be continuously poured into drinking-water by excreta, urine, laundry, etc., and so keep up the dangerous pollution of the water.

Numerous epidemics which have occurred in large towns, villages, barracks and cantonments can thus be explained by the consumption of polluted water.

The idea, therefore, of the pathogenic rôle of drinking-water still maintains its value in etiology.

The theory of germ carriers simply completes it, inasmuch as the pollution of water may be due not only to the excreta and urine of patients suffering from typhoid fever, but also to carriers as well.

In war-time contamination of drinking-water depends upon that of the soil.

In his hurry to relieve himself the soldier deposits his excrement without any precautions in ditches, on the side of the road, near wells, springs or water-courses, etc., and washes his clothes in the gutter.

Fæcal matter accumulates on the ground in enormous quantities, especially in stationary warfare, like the great war at the present day.

The result is that bacteriological examination rarely shows a water of wholesome quality. Most waters are intensely infected by B. coli and putrefactive microbes, which are constant associates of the typhoid bacillus.

Consequently, in war time one should *a priori* regard all drinking-waters with suspicion if they have not been thoroughly sterilised.

Paris has several times given a proof of the very important rôle of drinking-water in the epidemiology of typhoid fever. Brouardel, Thoinot, Chantemesse and Widal, Lancereaux and Mosny, demonstrated long ago that the distribution of Seine water was followed by twice to six times as many cases of typhoid fever in the hospitals. In 1894 and in 1900 the Vanne water, which was polluted at its source, was the starting-point of serious epidemics.

Dr. Hoel, Director of the Bureau of Hygiene at Rheims, has drawn attention to the epidemic of 1885, with 1500 cases and 142 deaths, which occurred for the most part in the Cérès quarter, inhabited by the working population, which drank almost exclusively well water into which cesspools soaked.

One of the most conclusive examples of the influence of water and its persistent action is given almost every year by Marseilles.

In 1907 this town had more than 3000 cases of typhoid fever with 423 deaths. In 1913 an equally severe epidemic occurred. Marseilles receives its water supply from the Durance, whose stream is exposed to the air and collects on its course human excreta, laundry water, etc. It is also supplied by the Rose and Huveaume water, the quality of which is equally doubtful.

Cherbourg, whose civil population and military and naval forces have frequently suffered from typhoid fever, owes its defective sanitary condition to the use

of the Divette water. From 1878 to 1887 its naval and military forces had 4162 cases, with 400 deaths! In February, 1909, a new epidemic occurred, with 300 cases and 60 deaths, among the soldiers and sailors. The river Divette, which is nothing better than a sewer, had been polluted on January 6 by the excreta of a woman suffering from typhoid fever, and continued to be contaminated throughout her illness. The first cases of typhoid fever occurred on January 25.

The epidemic of Saint-Brieuc (June 1909), in which about 900 civilians and 160 soldiers were attacked, was due to the washing of a typhoid patient's clothes in a laundry, the water of which ran into a stream which supplied the town.

The terrible epidemic of Avignon in 1911, and those of Marseilles in 1913, and of Montauban in the same year, were caused by the impurity of the drinking-water.

In the garrisons in Algeria, Tunis and Morocco, where prior to specific vaccination typhoid fever used to rage with an appalling violence, bacteriological examinations carried out in the laboratories regularly showed a considerable pollution of the drinking-water. In certain towns, indeed, systematic water analysis, by revealing an unusual pollution, enabled one to foretell epidemics which actually occurred a fortnight later. At Blida in 1893 a soldier, who wished to be sent to a convalescent hospital, intentionally swallowed a large quantity of condemned water (Oued el Kebir). He contracted typhoid fever from which he died.

The study of the epidemiological facts observed in every country, including England, the United States, Italy, etc., as well as in France, has fully confirmed the extreme importance of the bad quality of drinking-water in the etiology of typhoid fever, the immunity which those enjoyed who did not drink the unwholesome water, and the occasionally enormous incidence of the disease among those who did.

Beverages derived from water or containing water, such as ice, Seltzer water, lemonade, cider and milk,

may give rise to contagion. Epidemic cases due to the consumption of impure ice were reported at Vannes; eight officers who attended a banquet in which they partook of ice which came from a part of a river where several sewers opened, contracted typhoid fever. Two succumbed. Two, who had drunk beer, escaped (Major Dorange, 1898).

Milk is an equally dangerous element of contagion when it is drunk unboiled. Its contamination is due to its having been taken from the cow, or poured into a vessel by carriers with unclean hands, or to its having been collected in receptacles washed with dirty water, or diluted with water of this kind which contains the typhoid bacillus. In England Duncan recorded in 1873 the severe epidemic at Crosshall, which occurred among 500 families who had consumed milk infected by impure water taken from a stream into which excreta were discharged. The families who had drunk milk from another source escaped.

Guéneau de Mussy related in 1881 the history of the epidemic in Marylebone, which claimed 300 victims in a healthy quarter of London. The milk came from a farm in which there had been a case of typhoid fever. The farm well received the leakings of a cesspool. A sanitary inspector, who doubted that this was the cause of the contagion, drank the suspected water and contracted typhoid fever.

A very severe epidemic due to contaminated milk was observed in 1913 at Jargeau (Loiret). It gave rise to a high incidence of cases in certain families (Grancher).

Rôle of Flies.—The part played by flies in the propagation of certain infectious diseases has been proved for a long time. Attracted by the typhoid patients' excreta, vomit, urine, blood and pus, or by latrines and dung-heaps, *flies* carry off the typhoid bacillus on their legs and proboscis and convey it elsewhere. The typhoid bacillus lives in the intestines of flies (Celli, Odlum), which are therefore true bacillus carriers. They become filled with infectious microbes,

either some distance away or in neighbouring houses, and thus, laden with elements of contagion, they carry them into kitchens or canteens and deposit them on the food, fruit, pastry, milk, and the hands and face. They are contagious, not only by their legs and proboscis, but also, and perhaps most of all, by their excreta, for they defæcate very frequently.

Their danger is also due to their number, which may be extraordinary, especially in hot seasons or climates. *We have thus undoubtedly an explanation, in part at least, of the predominance of typhoid fever during the summer and autumn,* which are favourable seasons for the multiplication of flies, as well as in the towns or garrisons in the south of France, in Algiers and Tunis, Morocco and all the countries along the shores of the Mediterranean, where flies swarm in such abundance. This also explains why the houses of the poor, in which attention to cleanliness and hygiene is too often neglected, and which serve as a home for myriads of flies during the summer, are frequent foci of typhoid fever.

Attention has been called to contagion by flies, to their excessive frequency and their dangers in camps, especially in war-time, by army medical officers, during the expedition to Tunis, the Turco-Russian War (Dobroslavine), the war with Cuba, the Transvaal War, the Russo-Japanese War, and the war of the Allies with the Central Empires.

The "plague of flies," as an American doctor, Sternberg, called it, was the cause of the great frequency of the cases of typhoid fever seen in the Spanish-American War. Being inseparable companions of men and animals, *flies act as a powerful and formidable intermediary, and as a factor of contagion of the first rank.*

The English army doctor, Odlum, published in 1908 the account of a very severe epidemic which occurred in a regiment of Highlanders at Nasirabad.

The usual methods having failed, a systematic destruction of flies was carried out. The epidemic

which had ceased in July and August, returned when the flies reappeared. A search was then made for the breeding places of the flies, especially in the fæcal trenches, which were disinfected, and "not a single case more of typhoid fever was observed."

We need only mention, in passing, the rôle of fleas and lice, which has sometimes been invoked, but never actually proved. The relative rarity of the bacillus in the blood of the typhoid patient prevents us from supposing that this mode of active infection is frequent or even possible.

CHAPTER VII

CHARACTERS AND EVOLUTION OF EPIDEMICS ACCORDING TO THEIR CAUSES

In the previous chapters we have discussed the respective influence of the various factors in the etiology of typhoid fever. It would not be accurate to attribute an equal importance to each of these modes of contagion. Some there are, such as contagion by unboiled milk, oysters, shellfish, clothes, and raw vegetables, which, though fairly often observed, have not, however, the same frequency as others, such as the influence of adulterated drinking-water, contagion due to flies, direct contagion from man to man by patients or carriers, etc.

Though its importance has been discredited by some hygienists, the rôle of drinking-water, especially in big epidemics, undoubtedly still claims the first place. The substitution of a naturally or artificially pure water for one that is contaminated has been followed by an unprecedented reduction, or even by the almost complete disappearance of typhoid fever in a large number of towns. It is especially in the soldier, who reflects so faithfully the sanitary state of a town, that, thanks to the active and persevering measures demanded and obtained by army mèdical officers, a considerable improvement in sanitation has been obtained.

Brussels, London, etc., like Paris, have shown a very pronounced drop in their typhoid incidence and mortality, following the installation of large and expensive works for supplying pure water.

But drinking-water is obviously not the sole factor.

It would be imprudent to suppose that a pure water supply would rid the civil population and army for ever of typhoid fever.

In a number of cases bacteriological and chemical analysis of the water proves its good quality, whether it is that the cause of its infection is transient or the culture has been taken too late, or that the water really is pure.

If water can be excluded, in the presence of a diffuse epidemic without any appreciable co-ordination between the cases in time or space, one should think of one of the other causes which we have studied.

During the hot season, and especially in poor families, flies play an important part.

Investigation should be made as to contagion by one or more carriers employed in an occupation connected with the preparation of food.

In such cases the essential element of the contagion can be detected by the inquiry made and the bacteriological examination.

In the presence of an epidemic and with the object of cutting it short as quickly as possible, it is necessary to weigh the facts impartially, to construct a map and a table house by house of the cases observed, of their distribution, succession and successive onset. This simple analysis by means of the map may furnish very interesting information. Sterile or ill-founded hypotheses should be avoided, and laboratory help should be enlisted to detect the true factors.

It is important to know that when an epidemic has taken on a prolonged course, it is impossible to attribute it to a single factor of contagion. All causes and methods of transmission may be associated, such as direct contact with the patient, consumption of food which has been prepared by a servant who has neglected to wash his hands after attending a typhoid patient, contagion by a carrier who has also unclean hands, conveyance of the germ by that dangerous carrier the fly, by non-sterilised linen, a rectal thermometer or bedpan which has been con-

taminated by the stools or urine of a patient and not disinfected. These conditions combine with one another and become associated with the initial or fundamental cause to keep up the supply of epidemic cases and prolong their effects.

The *course* and *evolution* of the epidemics themselves owe their special character to the cause which provoked them. It has been well proved that epidemics due to water are widespread. They chiefly affect persons who have had no previous attack which could have immunised them. In towns, new arrivals, including soldiers, travellers and servants, are specially affected.

Furthermore, epidemics of this kind due to drinking-water have almost always a sudden and explosive onset, affecting a large number of individuals all at once, and in a short space of time, often within two or three weeks.

Such was the case in the epidemic of Auxerre (1884), so well studied by Dionis, which gave rise to 800 cases; in the Caterham epidemic (in the county of Surrey) in 1879, which affected 352 persons simultaneously; in the epidemic of Chatillon-sur-Seine (December 1883) described by Bourée; in the epidemics of Cherbourg and Saint-Brieuc in 1909; in the celebrated epidemic of Avignon in 1911, which gave rise to more than 1000 cases of typhoid fever, etc. These epidemics may last several months.

It is also observed that the first cases begin about fourteen to fifteen days after the use of impure water, a time which corresponds to the minimum duration of the incubation of typhoid fever. It is exactly the same in the cases of accidental absorption of the typhoid bacillus in laboratories. But, as the incubation period is not the same for all, a series of later cases may occur, twenty, thirty and even forty days, even after laboratory contagion.

Epidemics due to the use of unboiled milk contaminated by water, carriers, or flies show a similarly sudden and simultaneous character. The epidemic

is at first limited to single individuals, to the customers of the infected dairy, or to families which make use of the milk, and it affects those exclusively who have drunk it unboiled.

In like manner the consumption of oysters or shellfish by a number of persons may have a similar result.

It has often been noticed, and Netter has quoted some conclusive proofs, that ingestion of water or food contaminated by the typhoid bacillus causes on the same or following day an attack of indigestion accompanied by fever and diarrhœa.

Typhoid fever appears later at its ordinary date. It seems that this initial diarrhœa, which might indicate invasion of the organism by the typhoid bacillus, is more probably due to the absorption of other bacteria associated with the specific bacillus, such as proteus, the enterococcus of Thiercelin, bacteria of putrefaction, etc.

Epidemics due to contagion by flies show a sporadic character, without any apparent connection between the cases, and the history, as well as the search for carriers and water analysis, are unable to explain them.

Cases of typhoid fever due to contagion by carriers sometimes appear in an epidemic form, usually of limited extent, but more frequently in a sporadic (or epidemic) form. These cases are grouped in the same house, the same family and the same community. Their onset is less sudden than that of epidemics due to water, and their extent is less considerable.

They succeed each other irregularly and are abnormally prolonged, in every season, both winter and summer, with sometimes a long interval between each and without any obvious connection.

Their frequency depends, indeed, on the frequently intermittent discharge of bacilli in the excreta and urine, on their amount which is always less than in the actual course of typhoid fever, on the existence of attacks of diarrhœa, on the varying degree of cleanliness of the germ carrier, on his occupation, and the association of special circumstances which are very fortunately

not always combined, so that the chances of contamination are restricted.

It is needless to state that flies, those formidable agents for the transmission of pathogenic micro-organisms, and especially the typhoid bacillus, make their influence felt in summer and autumn. The accumulation of excreta and only a slight fall in the temperature may prolong their existence, not only in hot countries, but also in temperate climates.

During the war of 1914–1916, flies were sometimes found in the trenches and cantonments during part of November.

CHAPTER VIII

PROPHYLAXIS OF TYPHOID FEVER

Prophylaxis of Favouring Causes

THE description of the ordinary modes of contagion in typhoid fever will better enable us to deal with the various prophylactic measures against this infectious disease.

Considerable importance was formerly attached to the favouring causes of this disease. Although the bacillus remains the only responsible agent for this process, it will be well to consider these secondary factors and to endeavour in practice to restrict their action as far as possible.

We will therefore study the prophylaxis of the accessory causes which favour the outbreak of typhoid fever. *Specific or microbial* prophylaxis will then be discussed.

Among the conditions which most predispose to an attack of typhoid fever, age, fatigue or overwork and the influence of heat are among the most important.

Age, especially adolescence and the age between eighteen and twenty-five are predisposing factors which we cannot guard against. Nevertheless, they stimulate us to multiply during this period all the measures for removing or destroying the typhoid bacillus (the seed) or of immunising the susceptible subject (the soil). The same advice is applicable to young persons of both sexes who are devoted to sport and indulge in it to excess, which frequently leads to loss of flesh and cardiac or renal complications, and to those who are preparing for examinations and

competitions without sufficient hygienic precautions or the necessary relaxation.

In the army, experience has shown, contrary to certain apprehensions, that the soldier may be incorporated at the age of eighteen to twenty on the condition that he undergoes a progressive training. It is therefore necessary to confide experienced medical men with the hygienic supervision of young persons of both sexes who are devoted to sport, as well as of soldiers who have recently joined the army. Their physical education should be conducted with prudence, otherwise they will be more liable to infectious diseases in a severe form. A methodical and progressive training should be insisted upon.

For this reason the societies for physical education, military education and gymnastics should be warmly encouraged, for they help to form an energetic and supple race, which is better able to resist not only fatigue, but also the morbid conditions which are so liable to attack young persons.

Owing to the influence of the seasons on the appearance of certain epidemic diseases, the spring may be regarded as the most favourable date for the enrolment of young soldiers in peace time. In the Colonies it is best to mobilise soldiers in the winter.

Expeditions which begin during the hot season, or even at its commencement, have been paid for at the price of violent epidemics of typhoid fever.

It should be added that the prevention of the disease by anti-typhoid vaccination diminishes in the highest degree the influence of the favouring and determining factors which we have studied, just as the preventive and curative use of quinine, by creating a sort of medicinal immunity, has considerably reduced attacks of malaria and diminished the importance of its occasional or determining factors.

Side by side with physical overwork, demoralising causes and depressing emotions concur in predisposing to typhoid fever, and especially to grave attacks. Every practitioner should be familiar with these causes.

The general hygiene of the dwelling, its ventilation, the exposal of the rooms to the light, especially of the bedrooms in which man passes at least a third of his existence, the general cleanliness of houses, schools, factories, etc., and especially that of kitchens, dining-rooms, latrines and court-yards, and their proper ventilation, all constitute a collection of hygienic rules which are applicable not only to the prophylaxis of typhoid fever, but also to that of tuberculosis.

The same remark applies to barracks. For this reason it may be laid down as a principle that *the best position for barracks is in the heart of the country.*

Life in *camp* is in every respect more wholesome than in towns in which infections of every kind are often accumulated. The mess-rooms, latrines, urinals and punishment cells should receive special attention from the regimental medical officers.

The child should be instructed in individual cleanliness, including that of the face, mouth and hands. Regular washing of the hands, especially before meals, should be a constant habit and a sort of reflex for every one.

This early education, in spite of its importance, is too often neglected, especially in the country. It should form the subject of a few lessons in elementary hygiene by the school teacher. It should be taught early in life, so that it should not be forgotten that cleanliness is one of the manifestations of self-respect.

In this exposition of the prophylactic measures applicable against accessory or favouring causes we can obviously give only general indications. A detailed description is included in the rules relating to microbial prophylaxis, properly so-called. For this reason it will be sufficient to mention the favourable effects of a careful alimentary hygiene, and to recommend the use of pure water and wholesome food protected from dust and contamination of every kind.

In camps and cantonments, in peace time, and in the trenches, huts, and temporary or permanent encampments during war, one must combat the

formidable danger resulting from the infection of the soil by human or animal excreta, urine, kitchen refuse, residues of all kinds, as well as by dung heaps and putrefying matter which may harbour flies and their eggs. Such measures constitute indirect prophylaxis of the utmost importance.

Therefore, before occupying a village or a cantonment a careful inspection should be made, house by house, when possible—which the conditions of a war of movement do not always readily allow—a note should be made of unwholesome and badly ventilated houses, with their accumulations of manure which serve as huge breeding-places for flies. They should be cleaned, disinfected, washed and all the filth cleared out. The best means of profitably disposing of dung-heaps is to scatter them as soon as possible over the fields or the soil that is going to be sown, at a sufficient distance from inhabited dwellings.

If this measure cannot be carried out, they should be disinfected or even burnt. The health of the troops is the first consideration. The manure-pit and pond into which the rainwater and liquid manure drain must be filled up and the ground disinfected.

In permanent camps the ground should be hardened, and if possible paved, wherever the soldier is living and moving about, viz. the huts and tents, and at all events the sides of the road.

All depositing of manure should be forbidden. Incinerators should be built for destroying kitchen refuse, rubbish and filth, which may putrefy and attract flies.

Whenever the conditions of the site permit, latrines with drains and a water flush should be installed.

The hygienic arrangements of a camp should as far as possible resemble those of a town.

In the absence of a drainage system orders should be given to erect latrines with pails under strict supervision, or deep trenches which must be carefully disinfected twice a day in summer and once daily in winter.

The huts and tents should be ventilated during the day. The approaches to them must be strictly clean. Night latrines render real service not only in barracks, but also in cantonments and camps.

Should knowledge of the ordinary modes of propagation of typhoid fever be the exclusive possession of the doctor and hygienist? There is no doubt that if spread among the public in a suitable way it would have a good effect on the diminution of typhoid fever.

Education of the population in hygiene can only be carried out with the active assistance of public authorities and the participation of the medical profession. It should form an integral part of the instruction given to children (H. Vincent), and should be repeated in the case of the adult. In this way every one will be properly schooled in the principles of hygiene and become the conscious collaborator of the medical man.

One of the most important causes of the spread of epidemics of typhoid fever is to be found in the ignorance or indifference of the public. For this reason summary instruction, imparted in informal addresses given by a medical member of the Municipal Board of Health, the District Commission or the Council of the Department would serve to popularise the succinct principles which every one should know, relating to the parasitic nature of contagious diseases and their modes of propagation.

Popular instruction imparted at school, at the town hall, in the workshop or at home, will have far-reaching effects and be a valuable help to the laws and regulations on the prophylaxis of infectious diseases.

An immediate inquiry into the causes which started an epidemic, bacteriological study of the stools, examination of the blood by culture, or, failing that, by the serum test, will be of considerable help in the struggle against typhoid fever.

Bacteriological study alone can indicate the cause of the disease and thereby enable immediate measures

to be taken for the isolation of the patient, disinfection of the stools, linen, latrines, etc.

It will become possible by means of sanitary stations and laboratories of this kind to restrict the frequent cases of contagion from man to man, to exercise supervision over drinking-water, and to control its bacteriological quality.

Except in the army, in peace as well as in war time, in which all beverages are analysed and forbidden as soon as they are found to be unwholesome, bacteriological examination of water is practised in only a few towns.

There is another institution which is absolutely necessary, viz. a sanitary register of parishes and houses, with a record of all the cases of infectious diseases, and especially of typhoid fever. The cases of illness would thus draw the attention of the Boards of Health and facilitate the determination of the cause of epidemics.

CHAPTER IX

SPECIFIC PROPHYLAXIS OF TYPHOID FEVER

The progress of epidemiology has taught us the various stages through which the bacillus passes to reach man, as well as the direct causes and indirect factors in its transmission.

This knowledge having been acquired, the first measure in an epidemic consists in an exact bacteriological diagnosis (typhoid fever or paratyphoid), and a minute and as complete an inquiry as possible as to the first case and those which followed it, both at once and at a later date; in a word, as to the collection of conditions which may foster an epidemic or endemic state.

In dealing with an epidemic, which, after all, is only a collective disease, the epidemiologist should behave like a doctor with his patient. He should discover as soon as possible the exact nature of the affection, by having a culture taken early from the blood, both of patients and suspected cases,[1] and should then endeavour to discover the one or more causes of the disease and employ the appropriate remedies.

The prophylaxis of typhoid fever should have in view: (1) The patient. (2) The persons about him. (3) Carriers. (4) All inert and inanimate agencies which are capable of carrying the typhoid bacillus and passing it on to man.

Let us now discuss these various elements of contagion.

[1] It appears advisable to remind the reader that the earlier the blood-culture is taken the more likely it is to be positive. The culture should be taken again, and a larger quantity of blood should be used when the first culture is negative.

Every typhoid patient, including suspected cases, should be isolated as early and completely as possible. This isolation should precede notification, which is compulsory. It is unwise to await the confirmation of the diagnosis by the clinical symptoms and bacteriological examination before isolating the patient. In the case where isolation has not proved necessary, no harm results, but in the event of a positive diagnosis it must be remembered that the typhoid bacillus is present in large numbers in the stools, not only at the onset of typhoid fever, but even before the appearance of the first symptoms.

It will be necessary, therefore, to exercise supervision over the patient's household who may already have been contaminated.

All delay in the isolation of patients and suspected cases may expose a large number of persons to contagion, especially those in the immediate neighbourhood of the patient. Isolation should be completely carried out in the army, especially in war time. The patient should be placed under observation and removed without delay with a provisional diagnosis, if the febrile symptoms and digestive disturbances persist or get worse. It is right, however, to mention that in war time it is very common to observe transient infections which clear up in a few days as the result of rest, purgatives and restricted diet, and have no relation with typhoid or paratyphoid fevers. It is a peculiar fact which is worth noting, that during war time infections of all kinds which are in no way related to one another are apt to be accompanied by gastro-intestinal disturbance.

Blood-culture and, if necessary, cultures of the excreta and vomit, will help in the diagnosis.

In hot climates and in the East, and all the countries along the shores of the Mediterranean where malaria, papatacci fever (three-day fever), recurrent fever and Malta fever are prevalent, these diseases very often assume a typhoid disguise which may mislead the doctor. Laboratory examination will lead to the

adoption of the prophylactic measures required by an exact diagnosis.

No rational prophylaxis, therefore, can be carried out either in the army or in the civil population without aid from the laboratory.

As soon as the diagnosis of typhoid fever is established, prophylactic measures should be rigorously employed. After *isolation* of the patient disinfection should be carried out.

This applies to everything that has been contaminated by fæcal matter, urine and expectoration of the typhoid patient, and to the dead body as well. Disinfection of the walls, the air and the room in which the patient has been under treatment is of less importance. But disinfection of the floor,[1] which is frequently contaminated by excreta, and also of the linen, spoons, glasses and bath water should never be neglected.

Disinfection should also apply to persons who are looking after the patient. The relations and nurses may transmit the bacillus to those about them by means of their hands or their clothes, especially if they are in the habit of preparing the meals. They may also themselves become the first victims of their negligence or forgetfulness, if they are not vaccinated. Hands and clothes should, therefore, be washed or disinfected as often as is necessary.

Neglect of the *compulsory notification* of typhoid fever ordered by the law of February 15, 1902, and the decree of February 10, 1903, has too frequently entailed an extension of the disease and the omission of local measures of disinfection.

It appears certain that cases are not notified as often as they should be. Medical men have put forward the uselessness of this notification, because it is not always followed, especially in the country, by disinfection. But disinfection does not constitute the entire prophylaxis of typhoid fever, and it is for the practitioner to have the measures which we have

[1] *Eau de Javelle*, a hot solution of caustic soda and 5 per cent. solution of carbonate of soda form excellent disinfectants for floors.

already described carried out without it being necessary to have recourse to official intervention.

The rarity of notifications has also been attributed to the fear of hurting local trade by placing a ban on a business house, or to the infected districts being put out of bounds for men on leave by the military authority. Soldiers too frequently bring back to barracks the infectious diseases which they have contracted during the stay in their village. Such serious consequences demonstrate the absolute necessity for notification of typhoid fever and other contagious diseases.

If it were made after the doctor had formally expressed his opinion on the case, by the head of the family, or in his default by the lodger, as is the rule on the declaration of births, the notification would give rise to fewer objections.

As regards the persons who are looking after the patient or are in his immediate vicinity, arrangements should be made to vaccinate them; they should be impressed with the necessity of washing their hands carefully, wearing rubber gloves, changing their overalls or smocks when they are contaminated; and of never eating or putting their hands in their mouth in the patient's room.

Prophylaxis with regard to carriers.—No regulations or laws have been laid down in France with regard to carriers. The Academy of Medicine, nevertheless, in 1909 and 1910, expressed its authoritative opinion on this delicate question.

The existence of carriers undoubtedly complicates the prophylaxis of this infectious disease. The difficulty arises from the fact that these latent carriers, who are moving from place to place and so disseminating unconsciously the typhoid bacillus, are not as a rule revealed by objectively appreciable signs. It is only by the cultivation of their excreta that the pathogenic micro-organism can be discovered, and even then it is very difficult to isolate.

What measures should be adopted against this

source of contagion? Carriers obviously cannot be compelled to submit to compulsory isolation, or even to legal regulations obliging them to take minute precautions with regard to their excreta and urine. At least, nothing has been done hitherto in this direction. The gravity of the problem cannot be hidden. It is complicated by the fact that certain carriers remain so all their lives.

There are, indeed, no legal remedies for carriers. It is only in cases in which it is proved that they had a culpable intention of doing harm that the law could be applied to them.

Prophylaxis consisting entirely in investigating carriers and disinfecting their excreta could not cut short an epidemic. When undertaken locally in Germany in 1904, with an abundance of precautions and laboratory examinations which would render it inapplicable in an extensive area, this method seemed to diminish the frequency of typhoid fever in the region under supervision, but not in proportion to the effort expended.

All that it appears possible and useful to do consists in informing the carriers themselves of the dangers of their fæces and urine, and of the manner in which they can make themselves inoffensive, viz. *by careful washing of their hands after defæcation and micturition*, with prohibition to deposit their excreta near wells, springs, or in gardens, etc., sterilisation of body linen by boiling water, and giving up every occupation connected with the preparation of food. Carriers should be induced to take these precautions in their own interest.

Have there not been instances of cooks who were found to be disseminating typhoid fever, and were consequently turned out of all their situations? Some of them, however, to obtain a home had the excreta of a healthy person analysed in place of their own!

With convalescents from typhoid fever we are better able to cope. The recent recollection of the danger they have run, and the advice or apprehensions

of their friends, who have been enlightened by the doctor as to the contagious character of germ carriers, ensure precautions being taken for the time being. The difficulty is to enforce their observance for a sufficiently long period.

Persons suffering from biliary lithiasis, chronic jaundice, etc., should be told that they are, or may be, typhoid or paratyphoid bacillus carriers, and that the most serious results may occur if they follow an employment connected with the preparation of food or cooking.

But in actual practice the principle of individual liberty will doubtless long be a stumbling-block to the valuable measures which society claims against carriers.

We must, therefore, try to find a method by which the bacillus carrier can be effectually freed of the bacilli lodged in his gall-bladder, renal pelvis and bladder. There need be no question of cholecystectomy, which has been performed without causing the bacillus to disappear.

Specific vaccination of the carrier, even with the bacillus isolated from his stools, has not given a definite result. It is the same with the use of lactic ferments.

One is therefore led to conclude that *the best prophylaxis for the contagion due to carriers consists in preventive vaccination of all persons living in contact with them.*

Water and other Beverages, Food, Flies, etc.

Drinking-water is of great importance in the etiology of epidemics of typhoid fever. In the rural population, or small towns, in armies on manœuvres or on active service, well-water as a rule is responsible for this method of diffusing the germ. Every well and every spring ought, therefore, to be surrounded by a zone of protection against pollution by dung-heaps, latrines, etc. But the difficulty of realising such a measure in private property is very great.

The civil authorities, however, are entitled to impose a supervision over the *parish wells*, and to demand an adequate zone of protection. They may also insist on the closing of the wells in public establishments, hotels, restaurants, inns, cafés and bars, which have been found to be contaminated on bacteriological examination.

For the same reason the military authority forbids the troops access to these establishments. But in war time, in which half-measures are insufficient, we can but approve of orders which formally condemn infected wells, springs, streams, etc., and which *command a systematic sterilisation of all the water drunk by soldiers.* Various methods described in textbooks on hygiene (*v.* G. H. Lemoine, *Hygiène Militaire.* Paris, 1911) show how this may be carried out. The simplest, most practical and most efficacious method is treatment by *Eau de Javelle.* Alkaline hypochlorites added to water so as to give off one milligramme of active chlorine per litre of water form an excellent sterlising medium. The amount of chlorine must always be first estimated by a chemist or dispenser, as its amount varies considerably according to the origin of the *Eau de Javelle.*

For this reason calcium hypochlorite tablets of varying size have been advocated for the sterilisation of the water to be purified in precise amounts of one litre, ten litres, etc. (H. Vincent and Gaillard). Water purified by hypochlorites should not have a perceptible taste, but only just an extremely faint odour. The typhoid bacillus and the paratyphoid bacilli as well are killed on the average in ten minutes' time.

Numerous towns in the United States have regularly employed this process without any ill-effects. Free chlorine does not appear to attack lead or earthenware pipes, as these are protected by the calcareous coating deposited by water. At Paris treatment by *Eau de Javelle* is employed wherever the quality of the water becomes doubtful. It is therefore a method of very great and practical importance, costing little, inoffensive, and very efficacious.

We have said that other beverages than water, e. g. *milk*, can convey the typhoid bacillus. All families should always be urged to boil their milk, the danger of tuberculous contagion being added to that of typhoid and paratyphoid contagion. By having the milk boiled this double danger is easily remedied.

Cider, *perry*, *sour wine* and *beer* may also give rise to typhoid fever if they are diluted with contaminated water, or are contained in unclean vessels which have been washed with dirty water, or, lastly, if they are handled by carriers.

During the war of 1914–16 bacteriological analysis of certain beers from the north of France, which had been drunk by our soldiers, showed a very serious bacteriological pollution and an extraordinary number of micro-organisms.

The consumption of cider and of *sweet*, non-fermented wine to which impure water has been added is also not without danger.

The only method of prophylaxis consists in the analysis of these beverages and their prohibition, with penalties in case of disobedience on the part of the dealers, whoever they may be, and whether they have received a licence or not, but especially proprietors of public-houses, cafés, inns and restaurants.

Placards and notices put up throughout the villages, cantonments, etc., should call the attention of the populace and the soldiers to the harm and dangers of beverages of this kind.

The prophylaxis of typhoid fever due to *food* contaminated by fæcal matter or urine depends upon the causes which provoke this contamination. It seems unnecessary to remind the reader of the rôle of vegetables, fruit, radishes, salad, cress, strawberries, cucumbers, tomatoes, etc., to which the bacillus may have been brought directly by surface disposal, or indirectly by manure in epidemic times, or in districts in which typhoid fever is prevalent; it should be hardly necessary to order abstention from raw

vegetables, etc., or at least to subject them to careful and prolonged washing in cold water. It should also be noted that flies may convey the germs to them later.

The important question of surface disposal of human manure—a practice employed in a large number of agricultural regions—is closely connected with infection of food, as well as of the soil in market gardens, and of drinking-water, when the ground is fissured and provided with wells or cesspools.

The Academy of Medicine energetically condemned this unwholesome and deplorable custom in 1900. The *Law of February* 15, 1902 (Art. 1), forbade the *surface disposal* of human manure within the protective area surrounding wells; Art. 28 of the same law enacted penalties against any one who let excrementitious matter be introduced into well-water. Municipal authorities are, therefore, armed against surface disposal. But this repulsive practice is profoundly anchored in country habits, and habits are often stronger than laws. In fact, no legal measure has ever been taken against the use of human fæcal matter and urine, which has been the cause of so many cases of typhoid and paratyphoid fevers and of many deaths. It is at least necessary for existing legislation to be completed, reformed and strengthened, and for surface disposal to be forbidden in market gardens in which vegetables eaten raw, as well as strawberries, are grown, and also at a distance less than a hundred metres from drinking-places, springs, wells, etc., used for drinking purposes.

Lastly, prohibition of the use of the excreta of patients in private houses or hospitals should be equally absolute.

Epidemics of typhoid fever due to oysters have formed the subject of numerous reports. The supervision and regulation of oyster parks, and the prohibition to lay them in harbours, near the shore, or sewers, or to keep them in nets plunged in these germ-saturated waters, have several times been de-

manded (Mosny), but without effect. For this reason Fabre-Domergue has suggested the placing of oysters in pure sea-water for a few days to enable them to get rid of these harmful germs. It is to be hoped that such wise and useful measures will receive the support of the sanitary authorities.

As we have said, flies form important agencies for certain germs, such as the typhoid bacillus, the paratyphoid A and B bacilli, the cholera vibrio, etc. They settle by preference on food, especially fruit, sweetstuff, cream and pastry. Harm may, therefore, ensue from eating this food in epidemic periods when there are swarms of flies.

Everything that can prevent flies obtaining a fresh supply of germs should be recommended, including disinfection and cleanliness of the patients, their linen, bedpans, slop-pails, sinks and latrines, on which cresyl and chloride of lime powder should be sprinkled. The water-closet system represents a considerable progress in the preventive hygiene of typhoid fever, by limiting the contagion by flies and the deposit of germs in pails or the subsoil.

War on the flies themselves and their reproductive activity is carried on by disinfection of the places where they lay their eggs by means of sulphate of copper, cresyl and chloride of lime, by clearing out dung-heaps, cleaning manure-pits, etc. It has been suggested that the dung-heap should be placed on hurdles slightly raised from the ground; the pupæ of flies which infest the bottom layer of the dung-heap will then fall upon the ground, where they are gobbled up by the poultry in country places.

The protection of the windows and doors of kitchens and dining-rooms with wire blinds, the employment of meat safes and wire covers over the food, constitute an extremely valuable *mechanical protection*. This simple and useful method cannot be too highly recommended in kitchens and canteens in association with the other prophylactic measures recommended in this work.

To destroy the flies *in situ* pyrethrum powder dusted at night on the shelves, furniture and tables will be of great service. Fly-papers, traps, special vessels, bird-lime, etc., may be used in houses, hospitals, infirmaries and ambulances.

Good results can be obtained by leaving at night, in the kitchen and places where flies accumulate, plates and saucers containing milk, or, better still, ordinary beer, to which formol (1 in 10) has been added.

These measures should be officially ordered in slaughter-houses, pigsties, porkbutchers' shops, butchers' shops, tinned meat factories, and generally in all establishments and factories concerned with food.

CHAPTER X

PROPHYLAXIS OF TYPHOID FEVER IN THE ARMY

THE causes of typhoid fever are obviously the same in the army and in the civil population. The prophylactic measures already described find their application in a military environment. Owing, however, to its excessive susceptibility and almost uniform manner of life, food and age of its component parts, the army forms a special environment, in which prophylactic measures are perhaps more easily and readily carried out.

The creation of military bacteriological laboratories for the analysis of drinking-water, the cultivation of the blood and stools, the investigation of suspected cases and carriers; *the institution of the Chief Council for the Supervision of Drinking-water* intended for the army, which has rendered considerable service, the studies and reports to which the onset of epidemics at once gives rise with hygienic measures taken without delay, all testify to the important place taken by hygiene in our army.

The law of March 28, 1914 (Léon Labbé's law), makes anti-typhoid vaccination compulsory. Vaccination has been employed in certain French garrisons ever since the year 1911, first of all in East Morocco, then throughout the whole of Morocco, Algiers and Tunis. The appearance of formidable epidemics in certain garrisons, viz. at Avignon in 1912, at Montauban, Issoudun and Marseilles in 1913, and at Tours in 1914, determined at first the application and later the generalisation of this preventive method.

The description given in the general study of pro-

phylaxis will allow us to abridge our remarks in relation to prophylaxis in the army, both in war and peace time. Only a few supplementary details will be given.

As soon as an epidemic appears an attempt should be made to recognise and combat the initial cause, and to limit the extension of the outbreak. Consequently examination of the blood of patients and suspected persons should be made *as soon as possible* by the head of the district laboratory in time of peace, and by the bacteriologist of the army corps or army laboratory in war time.

After isolation and suitable cultures on special media, the most rigorous measures should be adopted as soon as the diagnosis is made. The patient is isolated in a special ward; in war time in a typhoid hospital. His stools, linen, bedpan and bath are disinfected in the way described below.

Removal to hospital must take place early. This should apply not only to undoubted cases, but also to incomplete forms, cases of gastric derangement and diarrhœa of a doubtful character.

The patient should be nursed by attendants who have been vaccinated against typhoid and paratyphoid, and are provided with a special set of clothes, which they should remove on leaving the ward. The attendants should wash their hands carefully after having bathed the patients, or changed their linen, or given them the bedpan or urinal. The use of rubber gloves is very useful, and considerably simplifies the precautions to be taken.

Typhoid cases suffering from secondary complications, such as streptococcal infection, pneumonia, diphtheria, etc., should be placed in isolation rooms, as such cases are undoubtedly contagious to other patients.

Soiled linen, bedclothes, handkerchiefs, drawers, etc., are steeped in buckets filled with warm water containing *Eau de Javelle* in the proportion of 20 per 1000. Linen thus treated can be handled without danger,

and does not allow any contagious particles to escape. Another method may be employed. The linen should be placed in a disinfecting bag consisting of strong and impermeable cloth, and the bags are then taken to the laundry. The high temperature of the washing soon gets the better of the typhoid bacillus.

Disinfection of the mattress and blankets is carried out in the incubator at 120° C. with steam to facilitate the penetration of heat.

The excreta are sterilised before being thrown away by means of a 5 per cent. solution of cresyl or a 5 per cent. solution of copper sulphate. The urinals, bed-pans and slop-pails, spittoons and their contents are also sprinkled with these antiseptic solutions and then scalded; water at 100° C. instantly kills the typhoid bacillus. Its bactericidal properties may be still more increased by adding 5 per cent. solution of carbonate of soda, which renders it alkaline and raises its boiling-point.

To disinfect woollen objects or clothes they should be treated with formol or formacetone vapour. Mattresses, pillows and bolsters require the same treatment, but they must be undone and the wool or horsehair exposed in thin layers to the action of these vapours.

One may also unpick and remove the covering of the mattress and plunge it in *Eau de Javelle* (20 in 1000) for twenty-four hours, and disinfect the wool and horsehair separately. But the use of the steam disinfectant is more practical.

Feather pillows and eiderdowns which cannot be sent to the disinfector should have their covering disinfected at the laundry and the feathers in formol vapour.

Spittoons should be treated with 5 per cent. solution of cresyl or a 2 per cent. solution of caustic soda.

Table utensils, such as spoons, plates, cups, etc., are collected in metal baskets of iron wire, and plunged for several minutes in boiling water rendered alkaline by a 5 per cent. solution of carbonate of soda.

Floors and walls contaminated by excreta or urine should be washed with a hot solution of 5 per cent. of caustic soda, or with *Eau de Javelle* of the same strength.

The installation of a drainage system in hospitals or wards greatly facilitates the emptying of the bed-pans and baths. When the baths have to be emptied by buckets after use a litre of *Eau de Javelle* should be poured into the bath, to disinfect at once the bath and its contents. The bath should not be emptied until some hours later.

We will now consider the prophylactic measures to be taken in barracks.

The cause of the epidemic having been determined, it should be combated without delay. It must not be forgotten that persons in the incubation stage of typhoid fever without any morbid symptoms disseminate the bacillus with their excreta in latrines. The water, if contaminated, should be boiled before use. It may be drunk after boiling, or as weak tea, if the barracks have no sterilising apparatus. If this is to be had, one must make sure that it is working properly, as examination has sometimes shown that it may be inadequate or imperfect. The rations must be supervised, and raw vegetables, strawberries and unboiled water prohibited.

If the epidemic originates in a town, the cafés, bars and restaurants must be put out of bounds, for the soldiers, who have wholesome water to drink in barracks, often contract the disease in such places.

The scale of work should be reduced.

After having sent the patients and suspected cases to hospital, and after having disinfected their sheets, bedclothes and body linen, the stretchers and ambulance wagon which have been contaminated by them should be disinfected if necessary. *An effort should be made to detect any abnormal forms of infection which may give rise to contagion.*

The doors and windows of kitchens, canteens and eating-rooms can be protected to advantage by a wire blind, to prevent the entrance of flies. Food

should be kept in a safe or under glass covers freed from flies. This *mechanical protection* against flies must be accompanied by the various precautions described in the last chapter relating to the destruction of flies, their eggs and larvæ.

We have already said that convalescents may have the typhoid bacillus in their fæces and urine. A search for carriers is possible only in peace time. Even then it does not yield all the results expected. Systematic disinfection of the latrines will serve to remove this cause of contagion if a drainage system does not exist. *One must on principle regard all excreta with suspicion.*

Carriers and, as an additional precaution, even those who have previously suffered from typhoid fever, should be forbidden any employment in connection with the kitchens, canteens, filters, or apparatus for sterilising water. Cooks should be ordered to wash their hands on their return from the latrines or the urinal.

During manœuvres all these measures are applicable. The same applies to *camps*.

Further, inquiry should be made of the municipal authorities about the sanitary state of the localities and villages in which the men will be quartered, and about any prevalent epidemics.

Specimens of water should be taken for rapid chemical and bacteriological examination (colimetry).

Inns and pùblic-houses should receive special attention.

On the march passage through infected villages should be forbidden. If this measure cannot be taken, the medical officer must ask for absolute prohibition being given to the troops to stop at all in such places to buy any milk or drink (cider, etc.), or take any water.

In camps in which very severe epidemics of typhoid fever have often been observed very strict measures should be adopted to prevent the invasion and spread of the bacillus.

The camp should not be erected over a previously infected site or over old fæcal trenches. These must be looked for and avoided.

The kitchens and canteens should be situated far from the latrines, fæcal trenches, urinals and stables, owing to the danger of flies.

Whenever it is possible, especially in permanent camps, a drainage system should be provided.

The fæcal trenches should be carefully supervised, and disinfected with chloride of lime powder once a day in winter and twice daily in summer on account of the flies. Their approaches should also be powdered with antiseptics.

The water should be analysed and, if doubtful, sterilised.

Raw vegetables and unboiled milk may be the source of grave dangers, and should be forbidden as soon as suspected or definite cases of typhoid fever appear.

The occurrence of the first case requires immediate and energetic precautions, viz. dispatch of the patient to hospital, removal of the tent, incineration on the actual spot of the straw on which he lay, disinfection of linen, contaminated objects, etc.

Removal to hospital, into an observation ward for doubtful cases, containing patients with gastric derangement, etc., has a real practical importance. Their linen should be sent to be disinfected as if they were really suffering from typhoid fever, and the straw on which they lay should be burnt.

As many of these cases are due to infection by paratyphoid bacilli, Thiercelin's enterococcus, etc., these precautionary measures will always be advantageous.

Soldiers must be forbidden, on pain of severe penalties, to pollute with liquid human fæces the camp soil, the approaches to the tents and huts, and the surroundings of wells or springs.

Night latrines with pails should be installed as in barracks, being closed by day and carefully disinfected. They should be lighted up at night.

Protection of food against flies and the destruction of the flies themselves must receive special attention.

Kitchen refuse, scraps of food and rubbish should be burnt in special destructors, easy to construct and provided with a powerful draught. They should be situated at one of the extremities of the camp, so that the prevailing wind does not drive back the smoke upon the camp.

The specific prophylaxis of typhoid fever *in war time* is obviously based on the same principles as those set forth above.

The establishment of army and army corps bacteriological laboratories, as well as mobile sanitary sections with portable apparatus, forms part of the prophylactic measures required by the fight against typhoid fever in war time. They inform the Health Service as to the quality of the drinking-water, the exact nature of the diseases, as well as the doubtful cases, germ carriers, etc. They make blood-cultures, diagnoses of the first cases, which are always so important, and bacteriological analyses of drinking-water.

As the causes of epidemics are multiple, the prophylaxis of typhoid fever always presents the greatest difficulties in armies on active service. The specific preventive method, vaccination, alone enables us to combat them all successfully at once. We shall deal with this subject later.

War conditions do not always permit of every prophylactic measure being rigorously carried out. Medical officers will therefore need much energy, persistence, self-confidence and initiative to obtain results. But these results are always forthcoming when prophylaxis is applied conscientiously, without forgetting or failing to carry out even the minutest detail. Any neglect, omission or half-measures result in prolongation of epidemics and the death of a large number of soldiers. It is the duty of the medical officers whose mission it is to give the orders, as for those who have to carry them out, to neglect nothing

in the war against the germ of typhoid fever. It is a fact that soldiers in general are opposed to hygienic measures of any kind. These must, therefore, be made compulsory, and it must be realised that the rôle of the medical officer and hygienist, which is to keep a large body of men in a sound condition, is one of national defence. The commanding officer should be associated with these measures, and his assistance obtained by convincing him of their value.

All the prophylactic measures, therefore, which we have recommended find their application in war time. The bacteriological control of drinking-water, its purification by boiling or treatment with *Eau de Javelle*, should be carefully carried out. The chief medical officers and the divisional medical officer should exercise a constant supervision, so that *the men should not drink any other water than that which has been purified.* Every one knows that the soldier has a natural tendency to drink any water he finds, whether dangerous or not. It is not, therefore, enough to show him the grave risks he is running. He must be prevented from drinking such water by police measures, such as closing or guarding a suspected well or unwholesome spring.

The fight against flies which carry harmful germs forms part of the necessary prophylactic measures, and should be accompanied by the destruction by incineration of fæces, rubbish, kitchen refuse and putrescible matter, or by their disinfection by chloride of lime, cresyl, or 5 per cent. solution of sulphate of copper. The methods of protection against flies have already been described.

The fæcal matter of persons in the incubation stage and during the actual disease, and of convalescents and carriers as well, remains the essentially dangerous element of direct or indirect contagion.

It is to be found in large quantities in places occupied by troops. There can be no question of making a search for typhoid or paratyphoid carriers in a very large body of men. The German method, which is of

difficult application in peace time with the technique at present available, would be out of the question in war time. It is simpler and more practical, as well as more rational, *to consider on principle all human excreta as dangerous and to treat them as such.*

Dung-heaps keep up the supply of flies, which multiply in an extraordinary degree in war time. These dung-heaps often form enormous accumulations, and it is not without difficulty that the sanitary service of the army can rid the cantonments of them. If one cannot force the inhabitants to do away with dung-heaps, it is best to have them taken away by fatigue parties, and spread in thin layers over the cultivated fields in the neighbourhood at a distance from the houses.

Men with suspicious symptoms should be urged to report themselves to the medical officer without delay. It has too often been found that soldiers suffering from typhoid fever do not report sick until they have reached the last extremity and their strength is giving way. Some have been able to go to the trenches although they had undoubted symptoms of the disease. This reluctance on the part of the combatant soldier has very grave consequences, both for himself because it is the cause of the high case mortality observed in the present war, and for others because it results in specific contamination of the ground, trenches, drinking-water, etc., with excreta rich in bacilli.

The problem of contagion in the trenches undoubtedly raises considerable practical difficulties. The makeshift latrines erected in well-sheltered offshoots from the trenches are not always used by the soldier, either because he is in a hurry to relieve himself or because he has to change his position, which sometimes exposes him to the fire of the enemy. The deposit of fæcal matter in the trenches where the soldier fights, rests, takes his food, and, generally speaking, lives for several days, results in contaminating his clothes, boots and hands. This contamina-

tion is obviously followed by that of the alimentary canal. When mixed with mud the fæcal matter escapes notice, and is therefore all the more dangerous.

The occupation of the enemy's trenches after a fight offers the same grave dangers of contamination. This is the explanation of the propagation of typhoid and paratyphoid fevers, dysentery, enterococcus infections and trench diarrhœa during the present war.

For this reason regimental medical officers should endeavour to prevent, whenever possible, any fæcal contamination of the soil of the trenches. The offenders and the companies in which these cases of uncleanliness are observed should be regarded as responsible, and ordered to disinfect the areas contaminated by the excreta with chloride of lime. The disinfected matter should then be buried in deep holes far from the water supply.

Except under special circumstances, patients and doubtful cases should make only a very brief stay in the ambulances situated near the lines. They should be taken to special infectious hospitals, where there will be facilities for isolating them, for making bacteriological diagnosis by blood-culture, repeated if necessary, and for nursing them.

The removal of typhoid patients should be carried out under supervision. Sterilisation of the patients' fæces and urine during the journey should be ordered. Arrangements should be made to avoid contamination of the transport vehicles, automobiles, wagons, boats, canals, etc. There may be some risk in transporting to a distance typhoid patients who have reached an advanced stage of their disease, in whom intestinal perforation or accidents due to myocarditis are to be apprehended.

The official report should indicate without delay not only the definite and exact diagnosis, but also the possibility of suspected cases, so that precautions should be taken early to cut short the epidemic.

All the special precautions and measures we discussed in detail when we dealt with the prophylaxis of

typhoid fever in the civil population, as well as in barracks, camps and cantonments and during manœuvres. There is, therefore, no need to mention these again. In addition to supervision of the drinking-water, protection against flies, disinfection of fæcal matter, urine, rubbish, etc., we may remind our readers that every man who has had an attack of typhoid or paratyphoid, especially recently, should be forbidden to act as cook, as he may be dangerous in this employment.

It would be well if every soldier's book contained as an appendix a chapter on hygiene, informing him in a simple and summary manner how infectious diseases are contracted, especially typhoid fever, the precautions to be taken to avoid them,[1] the dangers of alcoholism, etc.

Specific prophylaxis does not apply to the infecting germ only, or merely aim at its destruction. It should also endeavour to protect from infection by *active* immunisation all the persons exposed to contract the disease. This active immunisation is obtained by inoculation of the dead virus. Such is the principle of *preventive vaccination*, which has given remarkable results whenever it has been properly carried out. We shall deal with it after our epidemiological study of paratyphoid fevers.

[1] H. Vincent, *Congrès International de Médecine.* Section de Pathologie Militaire. Paris, 1900.

CHAPTER XI

ETIOLOGY AND PROPHYLAXIS OF PARATYPHOID FEVERS

Typhoid fever on the one hand, and paratyphoid fevers on the other, constitute entirely independent diseases. In spite of the close similarity of their symptoms, and although the bacilli causing them belong to the same family of micro-organisms, these affections do not confer upon each other reciprocal immunity. It may happen that the same person may contract in succession, and at a few months' interval, typhoid fever and then a paratyphoid fever. Cases have been known in which the three diseases, typhoid fever, paratyphoid fever A and paratyphoid fever B, have occurred within a little more than a year in the same person, who had been successively exposed to the contagia of these three diseases.

Such cases, undoubtedly, are not frequent. But one must consider the possibility of their occurrence in interpreting repeated attacks of typhoid fever in the same individual. Such cases are possible, but, in the absence of a blood-culture, an exact diagnosis cannot be made.

The nosological independence of paratyphoid fevers one from the other and from typhoid fever is also illustrated in epidemiology. Before the important discovery of paratyphoid bacilli by Achard and Bensaude in 1896, it is certain that the infections due to these pathogenic micro-organisms were usually confounded with typhoid fever, and sometimes with certain forms of cholera nostras. Bacteriological examinations, by indicating the exact nature of the infections and attributing them to their true pathogenic

agent, have helped to prove the existence of autonomous epidemics of paratyphoid fever. On other occasions cases of typhoid fever were found in association with paratyphoid fever. Before the war of 1914 paratyphoid fevers were seen in the form of small epidemics, usually of the B type. In the army, where, following the introduction of antityphoid vaccination, blood-cultures were taken from patients suffering from doubtful affections, this disease was found to be very frequent in soldiers, whether vaccinated or not. Some extremely violent epidemics which occurred at Marseilles, Avignon, Tours, etc., were exclusively due to the typhoid bacillus, and the local laboratories reported only a few isolated cases of paratyphoid fever B. Paratyphoid A was less frequent.

Sacquépée and Chevrel have noted that the town of Rennes was fairly often infected by paratyphoid fever. The disease is particularly frequent in parts of Paris and in the west of France (Brittany). It has been seen almost everywhere. In Europe, Germany forms the most important seat of paratyphoid A and B. This frequency of the disease, which may be so high as to constitute 10 per cent. of the diseases of a typhoid form, is doubtless connected with the nature of the food usually eaten in that country.

The existence of paratyphoid fevers has been noted in Italy, England, Holland, Roumania and other European centres; in Africa (Algeria, Tunis, Morocco, Libya, Egypt, Senegal, South Africa, etc.); in the United States, Brazil, Philippine Islands, Japan (Shibayama), Indo-China, etc. The disease is, therefore, ubiquitous.

War, by reason of the exceptional conditions which it creates, favours in the highest degree the appearance of gastro-intestinal disease, such as bacillary and amœbic dysentery, ordinary diarrhœa, and the so-called trench diarrhœa, as well as typhoid fever. The frequency of paratyphoid fevers A and B has thus been demonstrated, especially in August 1915, when they were predominant in the armies.

Vaccination against typhoid fever in no way predisposes to paratyphoid fevers A or B. Before the war with Germany these were extremely rare in the French Métropole army, although this contained more than 200,000 vaccinated persons. In the English army in India, which was almost entirely vaccinated against typhoid fever, there were only a few cases of paratyphoid fevers. It was the same in the United States army.

The war with Germany gave rise to a fairly large number of cases of paratyphoid fever through contagion (as well as of bacillary or amœbic dysentery), which were controlled by specific vaccination.

The influence of races and their predisposition to paratyphoid infection have not been settled. Cases appear to be more frequent in hot countries, but war, by greatly increasing the opportunities for contagion, is undoubtedly the most important of all favouring causes. Chevrel, on the ground that in a given country certain areas are specially affected, maintains that there are undetermined "regional influences." It is more probable that these influences are connected with defects in the hygiene of food, drink and housing.

Paratyphoid fevers are present in all seasons. But their curve is usually superimposed upon that of typhoid fever. It reaches its highest level in the months of August, September and October, *i.e.* during the hot period.

According to certain authors, the gravest forms are observed in winter.

All ages are susceptible, since young children, and even infants, may be attacked by paratyphoid as well as old men. The two sexes are affected in the same proportion.

Paratyphoid fever, either from its high contagiosity or as the result of ordinary conditions of infection, fairly often appears in small local or family epidemics, which may be very mild, or, on the contrary, severe. Its incubation period is generally from nine to fifteen days.

Etiology of Paratyphoid Fevers.

The chief causes of paratyphoid fevers A and B are the same as those of typhoid fever.

The paratyphoid bacilli gain entrance to the organism by the alimentary canal, reach the blood (where they are found on cultivation), and multiply in the lymphoid organs, spleen, bone-marrow, viscera, gall-bladder, etc. The bacilli are to be found in the blood during the first few days of the disease, but as a rule they stay there a shorter time than the typhoid bacillus. They are discharged in large quantities, and in a much more continuous and regular manner than the typhoid bacilli, in the excreta and urine. The mechanism of their elimination, however, is the same.

As in typhoid fever, paratyphoid bacilli may persist for very long after recovery, either in the fæces or urine. *Temporary* or *chronic* paratyphoid bacillus carriers are found who constitute, with the patients themselves, the disseminating agents of pathogenic bacilli.

The average proportion of carriers among those who have had paratyphoid fever is 4 per cent.

Paratyphoid bacilli are transmitted by the excreta, urine, pus and bronchial secretions, either directly by the patient or carrier to the healthy subject, or indirectly, intermediaries being very numerous, as in the case of the typhoid bacillus.

As our account of the propagation of typhoid fever applies to paratyphoid fever A and B, the present description may be curtailed.

Fæcal matter is the most dangerous of all the elements of contagion. This is why direct contagion fairly often affects nurses, visitors and patients in the next bed who do anything for them, as the hands are the most usual means of conveyance. They become contaminated when the patients are being attended to, *e.g.* when they are given a bedpan or have their linen changed.

In like manner, by depositing their excreta on the ground, or near springs and wells, or vegetable gardens,

etc., temporary or chronic carriers contaminate them, and may be the starting-point of epidemics of uncertain origin. In the case of carriers employed as cooks, the absence of cleanliness and neglect to wash the hands are equally important causes of infection in families, restaurants and houses, barracks, schools, refuges, asylums, etc.

The spread of contagion by food is certainly very frequent. But, unlike the typhoid bacillus, which is always transmitted in such cases by food which is secondarily affected and is incapable of infecting animals, *paratyphoid bacilli may readily multiply in animals*, giving rise to diseases the nature of which is not always suspected, and which are for that reason all the more dangerous.

Unlike typhoid fever, which is an exclusively human disease, paratyphoid infections, or Salmonelloses, may affect both man and animals, and be transmitted from the former to the latter and vice versa.

According to Morgan, Mori, and Gardenghi, the alimentary canal of domestic animals (dog, cat, rabbit, pig, etc.) may contain paratyphoid bacilli, and therefore the fæcal matter of animals, as well as human excreta, may serve as the means of conveying the paratyphoid A or B bacillus.

So, if this observation is correct, animals may become actual carriers of paratyphoid organisms.

On the other hand, the pig, ox, cow, calf, and much less frequently the sheep (Babes) and the horse, may be infected by bacilli belonging to the group of Salmonelloses, which includes closely related micro-organisms, especially *B. enteritidis*, which is most frequently found in food-poisoning. This bacillus causes in animals a rapidly fatal septicæmia, infective gastro-enteritis with profuse diarrhœa (in the calf), arthritis, metritis (in the cow), and closely resembles the paratyphoid B bacillus. Its pathogenic characters and reaction on sugar media are the same. Experimental or human serum, however, which agglutinates one of these micro-organisms, does not definitely agglutinate the other.

There is, therefore, a reason for separating them, especially as the symptoms which they cause in man are somewhat different.

Direct contagion by paratyphoid bacilli is, therefore, liable to be transmitted not only from man to man under the same conditions as the typhoid bacillus, but also from diseased or healthy animals (carriers) to man, and doubtless vice versa.

The factors of indirect contagion are necessarily also at work in the propagation of paratyphoid bacilli. They act more frequently than in typhoid fever, *because paratyphoid A and B bacilli are much more resistant than the typhoid bacillus to external causes of destruction.* They are more long-lived than the typhoid bacillus. They may persist longer in water and putrefying media like meat, in which the typhoid bacillus does not survive.

Drinking-water has frequently been accused of conveying the paratyphoid bacillus. Examples have been given by Sacquépée and Chevrel, and by Darde. Chevrel recorded in his thesis a mild epidemic of twenty-five cases of paratyphoid fever B which occurred after drinking the water from a cistern.

The injurious effect of drinking-water has been proved at Rennes, as well as in Germany, Austria, the United States, etc.

The use of impure cider prepared with contaminated water was incriminated in an epidemic which attacked the 35th artillery regiment in 1908, and gave rise to fifty-four cases (Follin and Fortineau).

In most of these epidemics the paratyphoid B bacillus was concerned.

Meat is still more frequently the starting-point for infections due to paratyphoid bacilli. These food infections, of which Polin and Labit and Sacquépée have given a very complete description, have sometimes a sudden and almost immediate onset, with symptoms of acute gastro-enteritis which may simulate cholera, and sometimes, on the contrary, a normal incubation with a more typical course. The immediate onset

of symptoms has been attributed to intoxication by thermostabile poisons developed in putrefying meat or coming from diseased animals: it has also been thought that putrefying meat contained toxic nitrites which might cause these rapid symptoms.

The later infective symptoms are due to infection by the paratyphoid bacillus, Gærtner's bacillus, or another representative of the group of Salmonelloses.

The contagious character of meat is explained by what we have said with regard to the latency of the paratyphoid B bacillus in the pig's intestine. In Germany bacilli belonging to the group of Salmonelloses are extremely common in pigs' intestines: 7 per cent. of the animals contain them, and sausages made with pigs' meat are also infected with the paratyphoid B bacillus.

It is in Germany, therefore, that the largest number of epidemic cases of paratyphoid fever have been seen following the ingestion of meat from diseased animals.

The possibility of infection can only be allowed when the meat (pork, beef, or veal) has been insufficiently cooked. According to Vallin, the central temperature of roast meat does not often exceed 45–50° C.; in hams weighing 5 kilogrammes the central temperature does not reach 60° C. after three hours' cooking. Now, typhoid bacilli are killed only at a minimum temperature of 57–58° C. prolonged for an hour. When infected food is given raw or half cooked to animals such as a monkey (van Ermengem), dog, mouse, guinea-pig or rabbit, a similar infection may result.

The remarkable power of resistance of typhoid bacilli explains how it is that after the death of the infected pig, ox or calf, *the bacillus continues to multiply rapidly*, especially in summer time, in pieces of meat, and also to secrete abundant toxines whose presence explains the symptoms which appear almost immediately. In this respect investigations made with *B. enteritidis* are conclusive. Persons who, under the impression that it was wholesome, partook of the

meat of some animals inoculated with the bacillus of the Morseele epidemic, were all attacked with gastro-enteritis. When kept in the ice-chest, the meat of these animals is, for this reason, much less dangerous.

The consumption of pork-butchers' meat, galantine (Netter), meat pies, black puddings, sausages of any kind, etc., has been the occasion of numerous cases of paratyphoid B fever. Further, as we have already said, it has frequently been possible to isolate the paratyphoid bacillus, by cultivation, from the inside of sausages or pies made with minced meat, or brawn. Organisms so isolated, in spite of their presenting the characters of paratyphoid bacilli, are not always pathogenic to the animals who are made to swallow them. Perhaps in such cases their virulence has disappeared or become attenuated.

It appears certain that when fresh meat gives rise to a large epidemic, the meat, which had been consumed shortly after slaughtering, came from diseased animals infected by the bacillus. In a total of fifty-one epidemics of Salmonelloses, Sacquépée found that nine were due to pork, seven to veal, and seven to beef. The meat of diseased poultry has sometimes been incriminated.

Leaving aside, however, the infections due to *B. enteritidis*, which are more common, but which, perhaps, should not be considered strictly as paratyphoid infections, it is none the less certain that paratyphoid bacilli may be transmitted by meat which is uncooked or is insufficiently sterilised by cooking. Meat pies, pork-butchers' meat, etc., may have themselves been contaminated secondarily, when they were being prepared in the kitchen, by a carrier's unclean hands; by contaminated instruments, vessels or tables; by the numerous flies which convey the micro-organism; by ice, etc.

In other cases the paratyphoid bacillus may be present in the intestine of the animal itself, and contaminate the sound meat when the carcase is being cut up. When the external temperature is high, the

bacilli also find a satisfactory culture-medium, and may multiply with extraordinary rapidity in mince, saveloys, sausages, pies, etc., all the more so as they are facultative anaerobes. This is the explanation of infections following the consumption of these foods. Preserved pork, ham (Pottevin), corned beef, dried goat's meat, sausages and *pâtés de foie gras*, galantine, etc., have given rise to such cases.

Contamination by hands, flies, ice and tables or vessels which have been used for infected food or meat furnishes an explanation of the cases of paratyphoid fever or fever due to *B. enteritidis* occurring after consumption of fish, semolina, vermicelli, cakes, beans, etc. Cream has also given rise to similar digestive disturbances. But in that case the micro-organism may have been brought by the milk.

Cases of epidemic paratyphoid fever are on record following the use of milk (unboiled). Max Levine and Fred. Eberson have related a similar case in the College of Ames, Iowa. The milk had been contaminated by the hands of a carrier or a convalescent who had been milking cows and bottling the milk.

Oysters, mussels, cockles, and other shell-fish are an equally frequent cause of paratyphoid contagion. Cases of this disease due to consumption of ordinary oysters, or so-called Portugal oysters, appear to be becoming more frequent, owing to the deplorable habit of those who own or lay oyster beds of keeping them in harbours, in water infected by fæcal matter and sewer-water.

Prophylaxis of Paratyphoid Fevers

The prophylactic measures relating to paratyphoid fevers A and B are identical with those of typhoid fever properly so called, but they also demand a special hygienic supervision of slaughtered meat, of insufficiently sterilised and preserved meats, vegetables and fish, as well as of all forms of pork-butchers' meat, because infection may be spread by the meat of diseased

animals, or their excreta, or the fæces of domestic animals who may be actual carriers of the paratyphoid B bacillus.

In the civil population, as in the army, complete cooking or effective sterilisation of preserved food of all kinds, prevents this special mode of contagion by destroying the paratyphoid bacilli, which are killed at 60° C. Milk ought not to be taken until it has been boiled. Lastly, food of any kind, whether sterilised or not, may become a cause of contagion, through being handled by carriers or exposed to contagion by flies. It is important, therefore, to find the carriers and to remove them from any culinary employment in boarding-houses, hospitals, asylums, etc., as well as in the army, both in peace and war time (kitchen, canteens). It will be wise to examine the stools of those who have had a paratyphoid fever before giving them employment of this kind. Persons who suffer from chronic hepatic or biliary lesions, such as jaundice or gallstones, are often open to suspicion; useful information can be obtained by examination of their stools.

We will not dwell any longer on the prophylaxis of paratyphoid fevers, but will refer our readers to what we have said in the chapter devoted to the prophylaxis of typhoid fever.

To facilitate this prophylaxis the notification of paratyphoid fevers should be made compulsory.

For paratyphoid fevers A and B, as for typhoid fever, vaccination constitutes the best prophylactic measure.

CHAPTER XII

ANTITYPHOID AND ANTIPARATYPHOID VACCINATION

The prophylaxis of typhoid and paratyphoid fevers has been most successfully completed by active immunisation against these infectious diseases. It may be said that considerable progress occurred as soon as this preventive method was introduced into practice in the civil population and the army. Numerous articles, to which there is no need to allude, have appeared on this subject.

Human vaccination was preceded by an experimental period. The principle of immunisation by living or dead cultures or their soluble products was established by Pasteur in the case of anthrax and fowl-cholera, and has since been extended by a large number of scientists to anthrax (Toussaint, Chauveau), symptomatic anthrax (Arloing, Cornevin and Thomas), the bacillus of malignant œdema (Roux and Chamberland), the bacillus pyocyaneus (Bouchard and Charrin), the bacillus of hog cholera (Theobald Smith, Salmon), etc., and lastly, in 1888 and 1892, to the typhoid bacillus by cultures heated to a temperature of 120 or 100° C. by Chantemesse and Widal, and to 50° C. by Bruschettini (1892), etc. Most of these authors used heat to kill the virus. T. Smith and Salmon, as long ago as 1886, immunised animals against hog cholera by several injections of cultures heated to 58° C., a temperature which did not impair the vaccine. The vaccination of man against typhoid fever is consequently due to Pasteurian methods.

Almost at the same period, *i.e.* in 1896, Pfeiffer and Kolle on the one hand, and A. E. Wright on the other,

applied to man vaccination against typhoid fever by heated cultures. As a matter of fact, it is the English scientist, A. E. Wright, who is the true initiator of this method in man rather than Pfeiffer and Kolle, who made no extensive use of the method, whereas A. E. Wright applied it in the English Army to a large number of individuals with very successful results.

Wright first of all made use of broth cultures ten to twelve days old, sterilised at 60° C. with the addition of 0·5 per cent. of lysol. Subsequently the duration of the cultures was reduced to forty-eight hours, and the temperature of sterilisation to 53° C. (Leishman).

But the bacillus was not quite killed at this temperature; the addition of lysol finally destroyed it. Three injections were made, the first consisting of 500 million bacilli, the second 1000 millions, and the third of 1500 millions.

After the publication in London of the *Report of the Antityphoid Committee*, according to which cultures heated above 65° C. lose their immunising efficacy, the sterilisation has been carried out at a lower temperature.

The vaccine employed in the United States since 1909 is that of Russell, prepared in the laboratory of the Army Medical School.

The bacilli are grown on agar for twenty hours, washed off with normal saline solution and then killed by heating to 55–56° C. for seventy-five minutes. A solution of 1 in 100 tricresol is then added. The vaccine contains 1000 million bacilli per c.c. It is employed in the American Army and Navy.

The vaccine prepared by Chantemesse is made in the same way as in the United States, 0·25 per cent. of cresol being added. It is used in the French Navy. Four injections are given. The doses injected are 0·25 c.c., 0·50 c.c., 0·75 c.c. and 1 c.c.

Le Moignic and Pinoy have recommended a vaccine made with killed bacilli suspended in sterilised oil.

Renaud has proposed a vaccine which has been exposed for thirty minutes to the rays of a quartz lamp.

Lumière and Chevrotier have proposed a dried and pulverised mixture of typhoid bacilli, B. coli and paratyphoid bacilli killed by heat. The powder is made up into keratinised pills which are swallowed.

Castellani was the first to attempt vaccination with living cultures; 310 persons were given cultures which were first attenuated at a temperature of 50° C., and then normal ones. Three or more injections were given. Nicolle, of Tunis, also used living cultures which had undergone two washings, the first a complete, and the second an incomplete one; the turbid supernatant fluid containing 14 million bacilli per c.c. Intravenous injections of this vaccine are given, the first containing 400 millions, the second 1200 millions.

Besredka's method is founded on the use of a living sensitised vaccine. The typhoid bacillus is cultivated for forty-eight hours on agar, washed in saline, and then treated with antityphoid serum. After remaining in contact with it for twenty-four hours, the living bacilli are decanted and washed and emulsified in normal saline. This vaccine contains 1000 million bacilli per c.c.: 1 c.c. is first injected, and then 2 c.c.

The use of living vaccines does not appear to have become general. The objections to it are (1) the possibility of those using it contracting typhoid fever, (2) of overworked or enfeebled subjects becoming infected with an immediate or delayed growth of the bacillus in their biliary passages, (3) the creation of carriers. The employment of a dead virus has therefore been more generally adopted.

It is possible to kill the typhoid bacillus by other means than heat, especially antiseptics. We have, in fact, seen that the vaccine of Wright and Leishman is much attenuated by a temperature of 53° C. and is killed by lysol. Semple has recommended carbolic acid (5 per 1000) which has recently been employed in the Italian army.

Ranque and Senez have proposed the employment of a vaccine sterilised by iodine, which has been in use especially at Marseilles.

The use of a vaccine sterilised by ether (H. Vincent) is founded on the principle that the typhoid bacillus and micro-organisms belonging to the same group are very sensitive to the action of ether. The typhoid bacillus is killed by ether in thirty-five or forty minutes on the average. Ether also possesses the advantage of removing the fatty substances which are present in large quantities in the protoplasm of the bacilli and serve to make the vaccine painful and fever-producing.

Vincent's vaccine is made of ten strains of typhoid bacilli of different origin, which makes it polyvalent. Strains of paratyphoid bacilli A and B have been associated with them from the first, *i. e.* since 1910 (*triple* vaccine).

The antityphoid vaccine as first used in the army was inoculated in successive doses of 0·5 c.c., 1 c.c., 1·5 c.c. and 2 c.c., but the number of injections was first reduced to three and then to two. Thus, in 1913, 26,000 soldiers were vaccinated with three injections each, in the XIVth legion with excellent preventive results. The total number of bacilli injected has varied from 1600 to 1800 millions.

Lastly, there has long been a question as to whether antityphoid vaccination could not be simplified under war conditions. In the Official Report presented in April 1914 to the Committee of the *International Health Office*, H. Vincent concluded that under these circumstances a modified vaccination consisting of only two injections of antityphoid vaccine should be performed with somewhat stronger doses; the immunity thus conferred being obviously less powerful and less prolonged.

This method was proposed and carried out at the beginning of the war, and in 1915 in the French army at the Front. The English army have also used it with heated vaccine, repeating the injections at the end of a year.

What is the quantity of vaccine needed to confer immunity, and what is the duration of this immunity? As a matter of fact, *the immunity and its duration are in direct relation* not to the number of the injections, nor even, properly speaking, to the quantity of vaccine

injected, but *to the number of typhoid bacilli inoculated.* The degree of virulence of the bacilli has no influence. The technique of preparing the vaccines should not aim at acting violently on the bacilli. Any pronounced modification, whether natural or artificial, of the micro-organisms weakens or destroys their powers of producing immunity, *e. g.* a temperature above 60° C., certain antiseptics, oxidising agents, etc.

A dose of 500 to 1000 million typhoid or paratyphoid bacilli killed by ether confers a considerable immunity, or considerably attenuates the gravity of the injection. The number of cases of typhoid fever which may occur during the year following an injection of 1300–1500 million bacilli killed by ether is 0·50 per 1000 on the average in a highly infected population. The duration of the immunity conferred by this dose is from one to two years on the average. The immunity may be affected by the degree of enfeeblement or overwork of the individuals who have been exposed to contagion.

The minimal protecting dose of antigen is between 1300 and 2000 million typhoid bacilli. With a dose of 3000 millions experience has shown that the proportion of cases of typhoid fever in the vaccinated who have been very much exposed to contagion is about 0·25–0·35 per 1000. The injection of 4000–5000 million bacilli killed by heat considerably reduces the susceptibility, even in soldiers who are engaged in fighting and are suffering from exhaustion. One frequently meets with a series of 20,000 vaccinated soldiers and more who have been exposed to contagion, *and do not show a single case of typhoid fever.*

The duration of the immunity resulting from the inoculation of 3000–5000 million of typhoid bacilli killed by ether exceeds four years, according to experience in Morocco, and it is very probable that in many of those who have been vaccinated in this way it may persist throughout life, thus resembling the immunity conferred by an attack of typhoid fever.

What we have called the "protecting dose" is weaker in the case of the paratyphoid bacilli A and B

than in that of the typhoid bacillus. Considerable immunity is obtained by 1000 and still more so by 1500 million of paratyphoid bacilli killed by ether.

It is obvious, therefore, that there is no need to inject excessive quantities of antigen to obtain protection against typhoid and paratyphoid fevers.

Mixed Vaccination.

The nature of the vaccination should obviously depend on that of the epidemic diseases which one has to fight. In epidemics in which typhoid fever is the only disease, antityphoid vaccine is used.

The co-existence of paratyphoid fevers in the same community which has been exposed to contagion should entail the use of a mixed vaccine or the successive injections of different vaccines. Both methods have been employed in the French army with similar results.

Castellani has vaccinated a certain number of persons against typhoid and paratyphoid fevers, and also against dysentery or cholera simultaneously by means of mixed vaccines.

It is, however, the double vaccine antiparatyphoid A and B or the triple vaccine antityphoid and antiparatyphoid A and B, which are most commonly employed.

The triple vaccine designated by the name of T.A.B. vaccine (ether vaccine) was first employed in the French army in 1910–1911. The same mixed vaccine was used in 1911 at the time of the first official application of vaccination in East Morocco. Some was sent in 1912 for use in the sections of the hospital orderlies, as well as in several garrisons of the Métropole army at Casablanca and Oudjda. Vaccination with the triple vaccine, or T.A.B., was repeated in East Morocco in 1913 and 1914. Since October 1914 the triple ether vaccine has also been used on a large scale by E. Sergent and L. Nègre, more than 100,000 men being vaccinated among the troops stationed in Algeria.

Its use has become more extensive since statistics have shown the relative frequency of paratyphoid fevers

among the armies fighting at the Front in the present war.

Lastly, the same triple vaccine, or T.A.B., sterilised by ether and prepared at the Institute of Milan, was employed in 1912 and 1913 among the Italian troops fighting in Libya and Cyrenaica, as well as in the garrison of Brescia and at Careno (F. di Cavellerleone, Santoliquido) with the most striking results.

Ever since the year 1911, successive attempts have been made in the French army, with varying proportions of typhoid and paratyphoid bacilli, to determine the best composition of the triple vaccine, that is to say, the one which combines the minimum reaction with the maximum immunity.

The mixed vaccine first employed in the French army contains 500 millions of typhoid bacilli per c.c. plus 250 millions each of paratyphoid bacilli A and B. Vaccination at present is performed with two injections of a vaccine containing per c.c. 1000 million typhoid bacilli and 500 millions of each of the paratyphoid bacilli.

Experience has shown that a more concentrated form of this ether vaccine may be used without causing more numerous reactions. A *single* injection of a larger dose may be given. The quantitative estimation of the bacilli is made at the Army Laboratory for the various vaccines, typhoid, paratyphoid A and B, or T.A.B., by means of the opacity-meter with rays selected by Vles,[1] tutor at the laboratory.

[1] The principle of this apparatus is as follows. Two luminous circuits derived from the same source traverse, one the vaccine to be tested, and the other an absorbing system (polarisation system) by means of which one can vary the intensity of the circuit. The rays traverse a coloured screen which allows only the red-orange light (λ 615) to pass. The rays constituting the two circuits form two juxtaposed images in the eye-piece of the same glass. The equalisation of the two portions of the field is established as in a photometer, and the graduation is read off. The latter, which depends upon the absorbing system, indicates the amount of bacteria in the vaccine examined, owing to the previous standardisation. This apparatus also allows one to determine what solution should be made in the stock emulsion of bacilli to obtain a vaccine with 100,000 bacteria per c.c.

This apparatus is exactly standardised against emulsions of bacilli in suspension in normal saline solution, whose quantity of bacilli has been determined by a previous count.

The Army Laboratory also prepares antiparatyphoid A or B vaccines, and mixed vaccines A and B, the former containing 500 millions and the latter 1000 millions (500 millions of each bacillus).[1]

In addition to the simple antityphoid vaccine Chantemesse and Widal also employ the triple heated vaccine (antityphoid and antiparatyphoid A and B), which contains 1500 million bacilli per c.c. Four injections are given with the following doses, 1 c.c., 1·5 c.c., 2 c.c., 3 c.c. When circumstances require it, three injections are given in doses of 1·25 c.c., 2 c.c., and 2·5 c.c. The triple heated vaccine, No. 2, is injected twice in doses of 1 c.c. and 2 c.c. respectively. It contains 3,300,000,000 bacilli or 1100 millions of each of the typhoid and paratyphoid bacilli.

The lipo-vaccine of Le Moignic and Pinoy contains 3000 million bacilli per c.c. One injection only is required.

The technique of injecting the vaccine is the same for all vaccines except as regards the region chosen. The injection is given subcutaneously, not intra-muscularly, either in the subclavicular region, or on the outer aspect of the deltoid area, or behind the spine of the scapula. The last site has been chosen because it is less rich in nerves and vessels, as the vaccine may sometimes penetrate a vessel and then give rise to an almost immediate febrile reaction.

Injections should be carried out aseptically. One should make certain that the ampullæ are hermetically sealed, as some of them may have been cracked in transit.

[1] It is important to know that certain glasses have a considerable alkaline reaction (0·010–0·018 per litre in NaOH). Vaccine prepared or kept in vessels or ampoules made of this glass undergo bacteriolysis and becomes much clearer. It has, nevertheless, a normal bacterial content.

Persons who have been vaccinated should be in a state of repose. Fatigue preceding or following the injection of vaccine is, indeed, an important cause of post-vaccinal fever. It is also accompanied itself by a temperature of 100·4° F. or more apart from any vaccination. It has therefore been found that vaccination of soldiers at the Front during the war sometimes causes much more numerous febrile reactions than behind the lines. These reactions are most pronounced in men who have come back from the trenches. On the other hand, *after a rest of several days*, they become very rare.

It has fairly often happened that soldiers who have been vaccinated have had to fight a few hours after the injection, without any complications developing.

In some foreign armies the men go to bed after they have been vaccinated. This practice obviously diminishes considerably the proportion of cases with vaccinal fever.

Another important precaution consists in making them take only a light meal (tea or soup) on the day of injection. Persons who have eaten to excess may suffer from vomiting or diarrhœa, in other words, from an attack of indigestion which it is consequently possible to avoid.

During the cold season precautions should be taken to prevent the soldiers catching a chill during vaccination. They should not therefore be undressed a long time in advance, and they should wait in a warm room. In vaccinated persons who suffer from pain in the limbs and fever, aspirin in doses of 50 cgm. soon causes relief. As is well known, this drug may produce skin eruptions, more rarely fainting attacks, or transitory anuria in predisposed subjects. Antipyrine should not be given, as it is a more frequent cause of these symptoms.

The commonest causes of a febrile reaction following injection of vaccine are as follows: (1) Fatigue or over-work; (2) Acute alcoholism; (3) Too large a

meal; (4) *Any acute concurrent diseases*, and certain chronic diseases, from sore throat to typhoid fever or paratyphoid fever, malaria, influenza, tuberculosis, etc.; (5) Lastly, but not invariably, a recent attack of typhoid fever, whether unrecognised or not.

It is well to insist on the reaction which occurs when vaccination is performed on persons who are in the *incubation stage* of typhoid fever or paratyphoid fever, or at the onset of these diseases or suffering from an ambulatory attack. The fever which appears then is analogous to that which is caused by the injection of tuberculin in the tuberculous, or of mallein in those suffering from glanders. In war-time when typhoid diseases are so common in the non-vaccinated, it is important to be familiar with all those causes which determine fever,[1] so as to refuse or postpone vaccination and to give the reactions observed their true interpretation.

A large number of reactions seen at the Front are due to the vaccination of persons who are already invaded by typhoid or paratyphoid bacilli. It may also be noted that many subjects who have been vaccinated during the incubation period, escape typhoid or paratyphoid fever, thanks to the injections, having acquired immunity before the period of general infection.

Accurate observations made during severe epidemics like those at Avignon, Tours, etc., have shown that when the vaccination is performed at the beginning, or even in the middle of the incubation period, the subject has a good chance of escaping typhoid fever.

[1] Some medical officers who had observed vaccinal fevers during an epidemic, thought of taking the temperatures of the soldiers to be vaccinated *before* giving the injections, during epidemics of typhoid, paratyphoid, influenza, or an eruptive fever. The thermometer showed that a large number of men were feverish and were already suffering from one or other of these diseases (Rouget, Tournade, etc.). Identical observances have been made during epidemics of influenza. *We have thus an explanation of a large number of febrile reactions*, which are not caused but increased or brought to light by the vaccine.

By taking the simple precautions which we have just described, the number of febrile and other reactions following vaccination is considerably restricted.

Consequently the actual number of definite contra-indications to the use of vaccination is limited.

In this description which deals exclusively with the practical side of the question, it is necessary to state exactly what these contra-indications are.

Some are *temporary*, others are *permanent*. The former have only a secondary importance, since they mean merely a postponement of the injection. It is best, therefore, to make a summary medical examination of the subject to be vaccinated, and if he is ill or worn out, to put him off till the following week. This procedure enables the indisposition or acute disease either to disappear or to show itself in its true colours. This simple precaution very often saves the doctor injecting a patient who might be suffering on the same day from an acute infection, such as pneumonia, meningitis, or an eruptive fever, with a grave prognosis, the explanation of which, as has sometimes been found, is too far removed from the truth.

It also considerably reduces the frequency of cases of fever by exclusion from vaccination of persons with slight affections, bronchitis, sore throat, etc.

Permanent contra-indications are the same in all countries and all armies (Wright), viz. severe organic disease, tuberculosis, chronic pleurisy, with or without thoracic deformity, arterio-sclerosis and aortitis, myocarditis, non-compensated endocarditis, diabetes, chronic nephritis with signs of renal insufficiency, hæmaturia, etc.

Malaria is by no means a contra-indication, with the exception of acute cases or malarial anæmia or cachexia. In Algeria, Tunis, Morocco, Salonica and the Belgian Congo, where malaria is very frequent, vaccination is in general use among the troops.

The only precaution consists in making the men with chronic malaria undergo a quinine cure and giving them 75 cgm. or 1 gramme of quinine on the day

preceding and on the actual day of the injection. Experience has shown the possibility of a return of a malarial attack when this precaution is neglected.

There is no harm in vaccinating syphilitic subjects. When they present active lesions one should wait until they clear up before performing vaccination. In some cases one may be at a loss to know whether vaccination should be performed. *A trial injection* should be given of ½ c.c. of antityphoid or antiparatyphoid vaccine, or 1 c.c. of the T.A.B. vaccine. The temperature should be taken two hours later and on the next morning. If there is a violent reaction one should postpone the case or else vaccinate with small fractional doses. This trial injection will be of great service.

The vaccination of subjects who are delicate but without any visceral lesions is quite feasible. It is very often found that they tolerate injections of vaccine without any reaction.

Recourse, moreover, may be had to the fractional method of giving weaker and more frequent doses, *e. g.* 0·75 c.c., when the case is not urgent. The total number of bacilli to be injected must, however, be given.

Tuberculous cases in which the process is stationary and not an open one, may be vaccinated if the general state is satisfactory, care being taken to put them to bed on the day of each injection.

It has been said that antityphoid vaccination predisposes to tuberculosis and pleurisy, but this does not appear to be the case.

On the one hand, tuberculosis is much rarer in soldiers in Algeria, where typhoid fever is frequent, than in France, where the latter disease is much less widely spread. On the other hand, it has not been found that a larger number of cases with acute or chronic tuberculosis occur among vaccinated than among non-vaccinated soldiers. This observation has often been made in the present war.

Vaccination against typhoid fever does not cause any predisposition to paratyphoid fevers, scarlatina, measles, cerebro-spinal meningitis, etc.

Cardiac cases with compensation may be given the benefit of vaccination by performing it in the manner already described by means of small and more numerous doses. It has also been performed with ordinary doses (H. Vincent, Bardot and Ledoux-Lebard, etc.). But it should not be done in the case of patients suffering from lesions of the aortic orifice, aneurysms, or those suffering from œdema, dyspnœa, etc.

Patients with myocarditis should not be vaccinated. This affection should be sought for in those who have previously had an infectious disease, such as diphtheria, pneumonia, broncho-pneumonia, typhoid fever, etc.

With these exceptions it may be maintained that the great majority of persons may be vaccinated without any harm.

Even advanced age is not a contra-indication, but diseases or lesions of the viscera and arteries may be an objection to vaccination.

Subjects of fifty-five or sixty years of age have been vaccinated before leaving for Morocco. At the Front when certain villages in the Argonne had been invaded by typhoid fever, the children and the youngest inhabitants were vaccinated. As typhoid fever then appeared exclusively among the aged, they were inoculated also, though they were sixty to seventy years of age, without any special incident occurring (Combe).

After having vaccinated albuminuric cases without finding any aggravation of their condition or fever in consequence, we recommended at the beginning of 1916 that young men with albuminuria should be vaccinated when they had no symptom of renal insufficiency. Observations in a certain number of depots (Paris, Versailles, Issoudun, Perigueux, Libourne, etc.), on vaccination with the triple vaccine or T.A.B., showed that not only did the frequency of albuminuria not increase or even keep at the same level, but that it actually diminished in 80 per cent. of the cases consisting of young men with varying degrees of albumin (from mere traces up to 0·50 gramme or 1 gramme of albumin).

Among 141 albuminuric cases who had received four injections of T.A.B. vaccine, examination of the urine made from a week to a fortnight after the last injection by the regimental medical officers or dispensers showed that albuminuria persisted in only twenty-one. Vaccinations of this kind were made in a large number of other cases of albuminuria with similar results (Peyrot, Fratelli, etc.).

It is obvious, therefore, that T.A.B. or typhoid vaccine has no effect upon the normal kidney. Some cases of paroxysmal hæmoglobinuria received the four injections. In Morocco German prisoners who had previously had bilious hæmoglobinuric fever were vaccinated without ill effect. Cases of nephritis, however, with œdema or symptoms of renal insufficiency and uræmia, as well as those who present symptoms of hypertension associated with cirrhotic kidney, should not be vaccinated.

Widal and Méry have vaccinated patients in hospital with albuminuria who showed none of the severe functional disturbances of Bright's disease. Some had had œdema, and one had had 11 grammes of albumin in the urine. Inoculation with heated vaccine was made under favourable conditions, *i. e.* in hospital, and while the patients were enjoying complete rest, circumstances which, it is true, do not occur in military practice. Vaccination did not cause a return of the œdema nor an increase in the nitrogenous retention. One of the patients had a return of hæmaturia four days after each of the two injections.

Widal and Méry conclude that every case should be postponed in which there is a recent history of hæmaturia or acute nephritis, or in which there has been more than a gramme of albumin per litre or more than 0·50 centigramme of urea per litre of blood serum.

We have already given the doses of heated vaccine and sensitised vaccine which should be employed. The doses of the ether vaccine for the adult are as follows—

1. Vaccine T (*antityphoid*), containing 500 million bacilli per c.c.

Complete vaccination { 1st injection 1 c.c. / 2nd „ 1½ „ / 3rd „ 2 „

or if *reduced* vaccination in two injections is performed—

Reduced vaccination { 1st injection 1 c.c. / 2nd „ 2 „

In less vigorous subjects these last two doses should be smaller, viz. 0·75 c.c. for the first, and 1½ c.c. for the second injection. But it goes without saying that the immunity conferred by reduced vaccination will be correspondingly *weaker and less lasting.*

Some medical officers, guided by the vigour of the subject, have given two injections of vaccine T, the first consisting of 1½ c.c. or 2 c.c., and the second of 2 c.c. or 3 c.c., without observing any abnormal reactions (Major J. Louis).[1]

2. *Antiparatyphoid A and B*, containing 500 millions of each of the bacilli per c.c.

1st injection 1½ c.c.
2nd „ 2 „

3. Triple *mixed* vaccine, antityphoid and antiparatyphoid A and B (*T.A.B. vaccine*), containing 500 million typhoid bacilli and 250 millions of each of the paratyphoid A and B bacilli.

Complete vaccination { 1st injection 1½ c.c. / 2nd „ 2 „ / 3rd „ 2 „ / 4th „ 2 „

[1] Some soldiers belonging to a company at the Front received by mistake *20* c.c. of the same vaccine at one time—*i. e. 10–15 thousand million bacilli*—without any complications beyond numerous marked febrile reactions. Of course this is not an encouragement to imitate this practice. An instance of a similar error had been previously published. A young lady who had been given 20 c.c. and two children who had been given 10 c.c. had a moderate febrile reaction (101·2° F.), but severe pain locally (H. Vincent).

If *reduced* vaccination is performed, the first three injections should be given.

Vaccination has been performed with large doses or with ether vaccine of high potency on a large number of soldiers, in *two* injections or even in a *single* injection. The reactions have not been more numerous and the preventive results have been excellent.

As has been said, the No. 2 ether vaccine contains 2000 million bacilli, or 1000 million typhoid bacilli and 500 million each of paratyphoid A and B bacilli. The doses to be injected are—

1st injection 1½ c.c.
2nd „ 2 „

The dose used for vaccination with a single injection is 2½ c.c.

Antityphoid vaccination and antiparatyphoid vaccination, whether separately or combined, may be performed during pregnancy in healthy women, and in children. Children aged two years and even eighteen months have been inoculated.

Children tolerate injections of vaccine remarkably well.

The doses of antityphoid vaccine or of the mixed vaccine to be given are as follows—

Child of	2–4	years	one-quarter	of the	adult dose.
From	5–7	„	one-third	„ „	„
From	8–12	„	one-half	„ „	„
From	13–16	„	two-thirds	„ „	„

In giving these doses the state of development of the children should be taken into account.[1]

As carried out under normal conditions and aseptically in young and healthy subjects *who are not suffering from fatigue or incubating a disease, mild or severe,* and in conformity with the ordinary rules (complete

[1] Children 11–12 years of age were vaccinated with the T.A.B. vaccine by Dr. Pilod during an epidemic in the army zone in the north of France, and received the same doses as the adult without ill effects. In children of this age, therefore, the prescribed doses may be increased and only two injections given.

rest for forty-eight hours, a light meal, abstinence from spirits or alcoholic drinks), injections of vaccine are followed by a relatively small number of febrile reactions, which is on the average 2 per cent. The pains in the limbs and headache are very soon relieved by one or two cachets of aspirin, each containing 0·50 cgm. Only one out of 400 or 500 persons has a temperature of 104° F., and even that is not always the case. Lastly, it may happen about once in 30,000 injections that through some of the vaccine penetrating a vessel there is immediate absorption of the vaccine, and shivering, fever, headache and vomiting at once develop. Rest in bed, Rivière's potion, and when the vomiting has ceased, small doses of aspirin (0·15–0·30 cgm.) every quarter of an hour cause the temperature to drop and bring the symptoms to an end. Some vaccinal reactions accompanied by hypotension, may be successfully treated by injection of ½ milligramme of adrenalin.

Experience gained from its use in millions of individuals proves that antityphoid vaccination is inoffensive (Bousquet, Ameuille and Brulé, Maurange, Chalchat, etc.).

Complications have been observed after every kind of vaccine in the armies of different countries. They really concern men who were suffering at the time of, or shortly after, vaccination from acute or chronic infectious diseases of grave prognosis (cerebro-spinal meningitis, pneumonia, broncho-pneumonia, suppurative pericarditis, suppurative peritonitis following appendicitis, chronic myocarditis, chronic aortitis, nephritis, and pleurisy), which have nothing to do with vaccination or vaccine.

It is therefore necessary to examine the individual carefully before vaccination.

It should be realised that identical observations have been made in *unvaccinated* soldiers, whose names were down on the vaccination lists and were on the point of being vaccinated. It not infrequently happened that these men suddenly fell ill and died some days *before*,

or even *on the day before*, or *some hours before* the time fixed for their vaccination. The lesions found post mortem were also those of meningitis, pulmonary or renal congestion, pneumonia, broncho-pneumonia, suppurative peritonitis, acute or chronic nephritis, etc. In twelve out of one hundred cases the lesions were insignificant, in spite of the severity and rapidity of the symptoms seen during life in these unvaccinated subjects. Fulminating or hyperacute forms of cerebro-spinal meningitis or poliomyelitis are often responsible for these sudden deaths, and the diagnosis is all the more difficult as macroscopic lesions have not always had time to form.

These facts show that, in presence of abnormal symptoms observed in a vaccinated subject, their cause should always be sought for in a concomitant morbid or infectious state independent of vaccination. Too much care cannot be taken to avoid attributing to vaccination diseases which may occur during the eight, fifteen or twenty-one days required for immunisation.

The successful results of preventive antityphoid vaccination are well known. In the French army and navy, as well as in the English, Italian and Japanese armies, all the published reports agree in showing the remarkable protection conferred by vaccines. It has been the same during the present war.

Antityphoid vaccination was employed in the English army in India after the memorable experiments of A. E. Wright. The German army made use of it much later, in 1904–1907, at the time of its expedition against the Herreros. During the Russo-Japanese war a certain number of vaccinations were carried out in the Russian sanitary formations.

In the United States antityphoid vaccination has been compulsory in the army and navy since August 28, 1911.

In the English army, before the war, antityphoid vaccination, though voluntary, was used in 90 per cent. of the soldiers in India. A few cases of paratyphoid fever appeared there, but typhoid fever has considerably decreased.

SOME EXAMPLES OF ANTITYPHOID VACCINATION

	Incidence per 1000		Mortality per 1000	
	Non-vaccinated	Vaccinated	Non-vaccinated	Vaccinated
English Army in India (1906–1908)	23·33	3	3·93	0·36
English Army in India (1910)	13·9	4·7	2·6	0·6
English Army (India, Egypt, Malta, Crete, etc.)	30·4	5·39	16·9	8·9
English Army in India (1911)	5·3	1·7	0·4	0·09
English Army (1914–Jan. 1915)	11·11	1 injection: 83 cases. 2 injections: 33 cases.		
German Army (War with the Herreros)	99	51	12·8	6·47
American Army (1910)	6·05	0·48	0·46	0
Japanese Army	14·52	1	1·66	0·28
French Army (Eastern Morocco)	64·97	0	8·35	0
French Métropole Army (1912)	2·22	0	0·30	0
French Army, Algiers and Tunis (1912)	12·14	0·09	1·88	0
French Army, Eastern Morocco (1912)	38·23	0	5·51	0
French Army, Western Morocco (1912)	168·44	0·18	21·13	0·09
French Army, Colonial Army Corps	6·34	0	0·58	0
French Army, Avignon epidemic (1911)	225·61	0	32·02	0
Paimpol epidemic (civilian population), (1912)	41·66	0	4·58	0
Puy l'Evêque epidemic (civilian population), (1912)	52·85	0	7·14	0
Italian Army (1912)	35·3	0·3	7·1	0
Italian Army (1913), Cyrenaica		0·29		0
Italian Army (1913), Tripoli		0		0

We have already stated that triple vaccination with the antityphoid and antiparatyphoid A and B vaccine

has been used in the French army since 1910. This triple vaccination with the Val de Grâce vaccine protected the soldiers who were inoculated in Eastern Morocco in 1911 against the three diseases.

Vaccination with T.A.B. vaccine was carried out in West Morocco, where the severity of typhoid and paratyphoid infections is well known. It was found that the mixed vaccine had a very powerful immunising action on the three diseases, whereas in the civil population of Morocco the non-vaccinated continue to provide numerous severe cases. French troops sent to Morocco at the beginning of the war with Germany, who could not be vaccinated owing to the necessities of the war, only managed to escape a severe epidemic—which began a fortnight after their arrival—by means of rapid vaccination.

In like manner, German prisoners sent to Morocco would have paid a heavy toll to typhoid fever if vaccination had not cut short the commencement of the epidemic. Their sanitary condition since then has remained excellent.

In Algeria, inoculation with the triple vaccine (T.A.B.) has conferred a remarkable immunity on the troops stationed in this country, where typhoid is so rife (E. Sergent and L. Nègre).

The Italian army also employed in 1912 and 1913 vaccination by the triple ether vaccine, or T.A.B., in Tripoli, Cyrenaica, and in Italy. Publications on the subject have been made by the medical Inspector-General Ferrero di Cavallerleone, and an official report has been communicated by Professor Santoliquido, Director-General of Public Health in Italy.

The vaccinations have been performed in Italy with the mixed T.A.B. vaccine, with three injections. The vaccinations were carried out in two periods: September 1912–June 1913, and June 1913–December 1913. In the first period the vaccines of Pfeiffer-Kolle and Vincent were used, in the second Vincent's T.A.B. vaccine almost exclusively, which had been prepared at the Milan Institute of Serum Therapy.

In the Libyan expeditionary force the non-vaccinated showed a morbidity of 35·3 per 1000 and a mortality of 7·1 per 1000.

In the first period 4682 injections were given with the Pfeiffer-Kolle vaccine, and 11,509 with the triple ether vaccine. In the second period 11,703 injections were given.

A platinum loopful of a culture on agar being taken as unity, as German bacteriologists advise, the doses inoculated were as follows—

	1st injection	2nd injection	3rd injection
Vincent's vaccine	0·40	0·90	1·20
Heated Pfeiffer-Kolle vaccine .	0·50	1	2

The Pfeiffer-Kolle vaccine has thus been given in much larger doses.

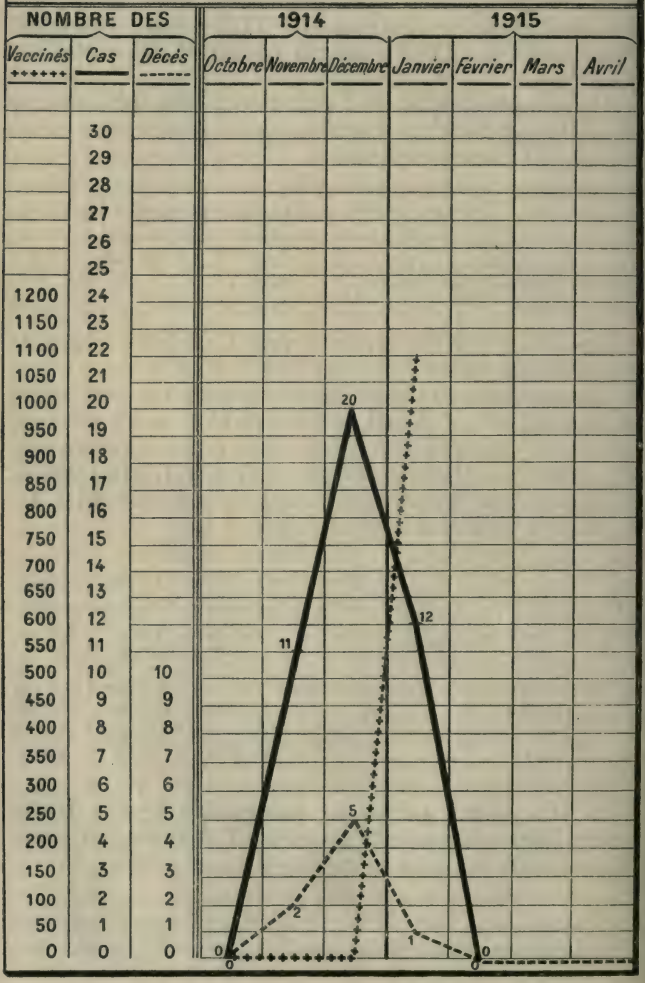
The statistics of the morbidity among the vaccinated in the region of North Africa, which is so severely infected by typhoid fever, have shown the same remarkable results as those in the French army, in the interior, in Algiers and Morocco, in striking contrast with the morbidity of the non-vaccinated.

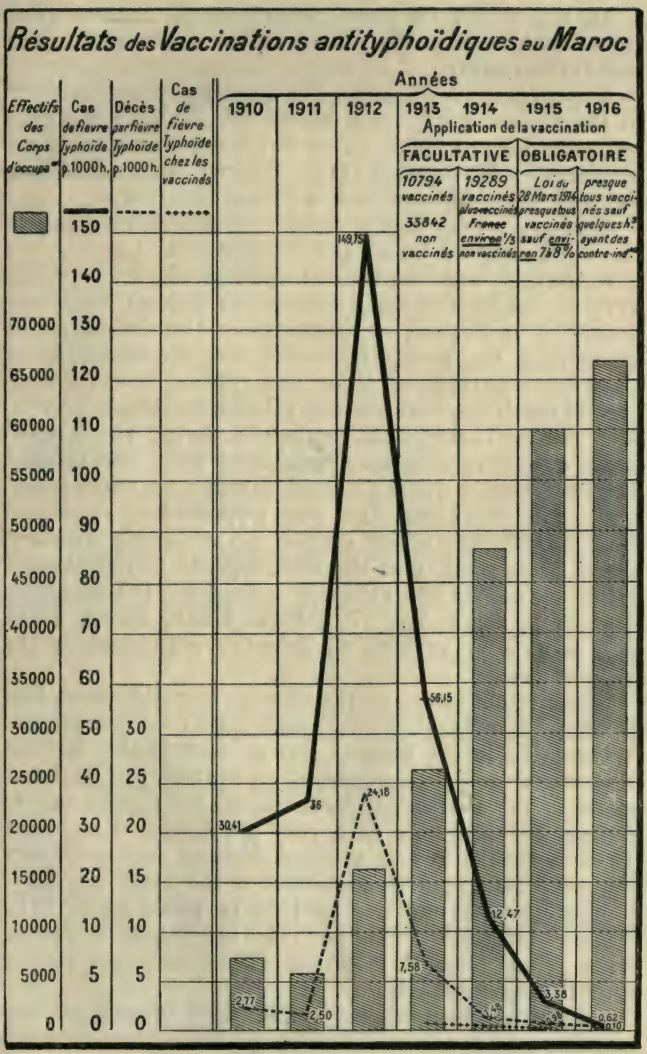
Vaccinated	Number of Cases of Typhoid Fever		
	1 injection only	2 injections	3 injections
1. With the triple ether vaccine (T.A.B.)	4·4 per 1000	2·7 per 1000	0·3 per 1000
2. With the heated vaccine (Pfeiffer-Kolle)	10·7 per 1000	6·9 per 1000	7·2 per 1000

In the second period of vaccination in the Italian army, 3494 soldiers were given the T.A.B. ether vaccine. Their morbidity and mortality were as follows—

	Cases	Deaths
In Cyrenaica	0·29 per 1000	0
In Tripoli	0	0

Résultat de la Vaccination
au 66e Bataillon de Chasseurs.




Résultats des Vaccinations antityphoïdiques au Maroc
Années
1910
1911
1912
1913
1914
1915
1916
Application de la vaccination
FACULTATIVE
OBLIGATOIRE
Effectifs des Corps d'occupation
Cas de fièvre Typhoïde p. 1000 h.
Décès par fièvre Typhoïde p. 1000 h.
Cas de fièvre typhoïde chez les vaccinés
10794 vaccinés
33842 non vaccinés
19289 vaccinés plus ou moins
France environ 1/3 non vaccinés
Loi du 28 Mars 1914 presque tous vaccinés sauf environ 7 à 8 %
presque tous vaccinés sauf quelques h.s ayant des contre-ind.
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
5
0
30
25
20
15
10
5
0
30,41
36
149,75
56,15
24,18
12,47
7,58
2,77
2,50
3,38
0,62
0,10

As the result of these observations, Ferrero proposed that vaccination should be made compulsory in the Italian army.

Antityphoid vaccination has been made compulsory in the French army since March 28, 1911, on the proposal of Léon Labbé. The navy adopted the same measure in November 1914. Shortly afterwards the Belgian War Minister took a similar decision.

Since the war began simple or mixed vaccination has been adopted by all the belligerents.

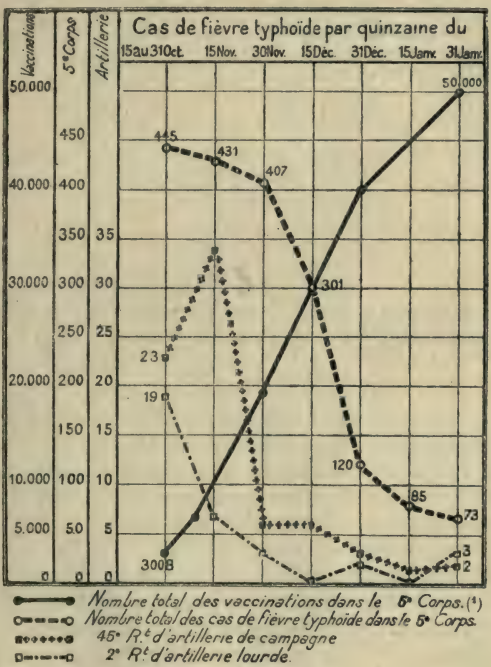
It may be asserted that in spite of the occasionally very unsatisfactory conditions under which it has been practised in France, in spite also of the difficulties of controlling the vaccinations and the actual nature of the infections (typhoid fever, paratyphoid fever, enterococcus infection, and various other infections), preventive vaccination has succeeded in saving the French army a very considerable number of cases and deaths. Reduced vaccination, although involving a correspondingly reduced immunity, has nevertheless conferred considerable protection on the corps among which it could be applied from the first, *e. g.* 5th Corps (Javal), territory of Belfort (100,000 vaccinated: Bousquet), 4th army, 5th army, 77th, 98th, 235th, 243rd, 364th divisions, etc., as well as infantry regiments in the Belgian army.

The circumstances of the present war did not at first permit of the universal employment of preventive vaccination in the army. But as soon as this method was introduced and submitted to control, the epidemic curve in the armies was found to drop suddenly and to remain subsequently at a very low level. Ever since 1915 mortality due to typhoid diseases has been very low, and the sanitary condition of the army has for a long time been superior to that in peace time. The Russian brigades which have been vaccinated in France with from 1 to 3 injections have also enjoyed a remarkable immunity.

Owing to the nature of the military operations, the continual stagnation of the troops in the trenches and

cantonments, the enormous effectives engaged, and the long duration of the war, it may be calculated that specific vaccination has saved the country "an extraordinary proportion of cases" and an extremely high number of deaths.

Before the war with Germany (we have no need to



allude to the now classical example of the Avignon epidemic in 1911, when among 687 non-vaccinated soldiers there were 155 cases of typhoid fever with 22 deaths, whereas among 1366 completely vaccinated there was not a single case of this disease), a young doctor who had been vaccinated during the incubation stage had a suspicious febrile gastric attack. Three

mild cases also appeared after the first or second injection in men who were in the incubation stage, and consequently already infected at the time that the injection was made.

EPIDEMIC OF AVIGNON (1912)

Present numbers of the garrison	2053
Number of vaccinated soldiers—	
1. Before the epidemic	525
2. During the epidemic	841
Total number vaccinated (ether vaccine)	1366

DEATHS FROM TYPHOID FEVER

	Cases		Deaths	
	Number	Incidence per 1000	Number	Incidence per 1000
Non-vaccinated 687	155	225·61	22	32·02
Vaccinated 1366	0	0	0	0

The following year the complete garrison of Avignon, containing 2420 men, was vaccinated, and there was no case of typhoid fever. Among the soldiers in this town, from 1892 to 1912 inclusive, there had been 1263 cases of typhoid fever and 118 deaths. In 1913 all these figures were reduced to zero.

Similarly conclusive observations were made on the occasion of the military epidemics of Larissa (Greek army, 1912), Marseilles, Issoudun, Tours, etc.

At Tours a severe epidemic of typhoid fever occurred in January–February, 1914. A single company of the 66th infantry regiment had 37 cases out of 180 men. The company was vaccinated at once and the epidemic ceased, but it appeared again in the other companies. Influenza, scarlatina, mumps, and cerebro-spinal meningitis were prevalent at the same time. Nevertheless, the whole regiment was vaccinated, and the epidemic was thereby brought to an end. This epidemic

was almost comparable in severity to that of Avignon. The figures are as follows—

Tours Epidemic		Cases		Deaths	
		Number	Proportion per 1000	Number	Proportion per 1000
Non-vaccinated	488	96	199	21	43·40
Vaccinated	1646	0	0	0	0

The vaccinations carried out in the civil population at Avignon (400 inhabitants), Puy l'Evêque (Lot), Paimpol, etc., on the occasion of severe epidemics gave rise to the same conclusive observations. In a certain number of places or towns, *e. g.* Grans (Bouches-du-Rhône), Rouffignac (Dordogne), Alais, Egletons (Corrèze), Sermaizes (Loiret), Ymouville (Eure-et-Loir), Andilly and Margency (Seine-et-Oise), Donges (Loire-Inférieure), etc., the protection acquired by the vaccinated proved to be remarkably complete.

We may quote as an example the cases of the epidemic observed at Largeau (Loiret), from June to September 1913, by Dr. Grancher. This epidemic was due to milk, and fourteen families making use of the infected milk were attacked. Dr. Grancher vaccinated the members of seven families with Vincent's vaccine, and the other seven refused. The result was that typhoid fever continued for three months by means of contagion from person to person in these families, among whom it caused fearful ravages, all—or almost all—their members being attacked in succession. In one of these families seven persons out of eight had typhoid fever in succession. The grandmother alone, aged seventy-two, escaped. On the other hand, the inhabitants (eighty persons, including forty women and eight children) who had been vaccinated even partially were entirely protected against infection.

At Sivas (Turkey in Asia), Seville (Prof. Juan Peset), where 624 persons were vaccinated, Noguer (Spain),

the Belgian Congo (Dr. de Ruddère, Dr. Polidore and Dr. Valche), Medellin (Columbia), Connixheim (Belgium), etc., similar examples of immunity have been observed.

A very important fact is that when the inoculations are rapidly carried out on all the persons liable to infection, they exercise an arresting action upon the epidemic, which dies down rapidly when the second or third injection of vaccine has been given.

The statistics published by Leishman for the English army in India and the other colonies, by Russell for the United States army, etc., testify, with the authorities already quoted, that *specific vaccination is the most powerful prophylactic measure which we possess against typhoid fever.* From this point of view it may be compared with vaccination against smallpox.

Before concluding, it seems imperative to insist on the absolute necessity of applying vaccination rigorously to obtain all the effects which one is entitled to expect from it. The difficulties in practice due to the state of war are obviously great.

Furthermore, the frequency with which the soldiers to be vaccinated are leaving or changing their billets explains the fact that vaccination in war time may be carried out incompletely, or improperly registered or controlled. Errors are likely to be all the more numerous as enormous bodies of men are being dealt with. We cannot, therefore, too frequently repeat the advice to conform minutely to the practical rules for vaccination, to enter each of the injections carefully and with rigorous exactitude on the vaccination card, and to keep a record of it in a special register.

During the arrival in large numbers of men to be vaccinated, either in barracks or at the Front, numerous causes of error may arise, such as entering men absent or postponed on the list of those actually vaccinated, hasty signing of certificates, frauds due to the soldiers, any one of whom for a consideration will take the place of another and reply when his name is called out, while

others imitate the Medical Officer's signature and reproduce it in their books, or obtain an inaccurate certificate from an obliging orderly. The attention of Medical Officers who perform the vaccination should be called to these facts, and to their frequent results. Inquiry, in fact, has proved the great frequency of mock vaccinations in war time.

It will be well to remember that many soldiers confuse vaccination against smallpox with antityphoid vaccination—Wright formerly drew attention to the same occurrence in the English army—and a large number still appeal to a vaccination which does not exist to escape injections.

Medical Officers who are entrusted with the carrying out of vaccination should provide themselves with reliable assistants, and take the greatest care not only in the technique of the injections and previous examinations of the subjects to be vaccinated, but also in everything concerning the verification of the states of vaccination, the exact control of the injections performed, with their dates and doses, the registration of the absent, sick, and those on leave; for any neglect or forgetfulness may result in attributing an undeserved failure to this successful method, and, what is more serious, in exposing soldiers to a dangerous infectious disease, the prognosis of which is often fatal.

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